UNIVERSITY OF SOUTHAMPTON

FACULTY OF ARTS AND HUMANITIES

WINCHESTER SCHOOL OF ART

Investigation of People Aged 65+'s Home Living Room Experience for Improving Living Room Design in the UK

by

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Thesis for the degree of Doctor of Philosophy

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ABSTRACT

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As the world population is ageing, many researchers have explored and contributed to improving older people's quality of life from diverse perspectives, such as social care, healthcare, homes, transportation, and pension systems (ONS, 2018; Wittenberg and Hu, 2015; NICE, 2013; Kim et al, 2011; Martín, 2010). Although home related risks such as falls, collisions, fires and security have been well documented in the context of stairs, bathrooms and kitchens, older people's experience in the living room has been neglected in the UK. The living room has been identified as one of the most frequently used spaces at home. It is multi-functional: used for reading, tea/coffee, TV and entertainment, meeting with friends, meals, and even sleeping. Due to the frequent use and multi-functionality of the living room, older people's interaction with their living room is far more complex compared to other functional rooms (bathroom and bedroom). Thus, it is worth exploring potential risks (such as collisions and falls) and challenges older people face with different daily activities in the living room. This project aims to investigate the experiences of older people with their living room at home so as to identify risks and challenges they face in their day-to-day life and indicate the reasons behind it, then develop design insights for improving living room space design, furniture and

furniture arrangement, and atmospheres design so as to improve older people's living room experience in the UK. There are three key research questions:

1. How do older people currently use their living rooms for different activities and purposes?
2. To what extent do older people experience challenges and hazards in their living rooms?
3. How can we improve the living room environment for older people in the UK through better inclusive design?

In this study, the English Housing Survey (EHS) was utilised to design a sampling strategy to identify participants who represent older people's living situation in the UK representing different characteristics. An ethnographic user study approach was employed to explore older people's natural behaviour with multiple activities in their living room through video-based observation, in-depth interview and cultural probes. Qualitative content analysis was applied to analyse the collected data in order to identify key factors that have an impact on older people's living experience in their living room. Finally, all findings from this project help the author to develop design insights for improving living room space design, furniture and furniture arrangement, and atmospheres design so as to improve older people's standard of living in the UK.

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Research Thesis: Declaration of Authorship

Print name: Shan Wang

Title of thesis: Investigation of People Aged 65+'s Home Living Room Experience for Improving Living Room Design in the UK

I declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
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6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. None of this work has been published before submission

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Definitions and Abbreviations

Older people

The World Confederation for Physical Therapy (WCPT, 2020) indicated that older people might be defined crossing a range of characteristics, such as chronological age, change in social role (such as retirement) and change in functional abilities (such as disability). Moreover, the elderly population is normally defined as people aged 65 and over (OECD, 2018). For this project, the author uses the terminology of 'older people' as a general definition of an older person aged 65 and over. This cover all social roles and body functional abilities.

Inclusive design

Inclusive design is a general approach for designing products, services and environments that are accessible to all, regardless of age, (dis)ability or other factors (Design Council, 2006). Inclusive design for this project is defined as environment design and product design related to older people's home environments so that they can be easily and safely used by older people, no matter what gender, household type or disability (Inclusive Design Hub, 2018).

Space design

For this project space design is defined as design elements that cannot easily change or move in a living room, such as the shape or size of the room, flooring and walls, doors, windows and switches or sockets on the wall.

Atmosphere design

For this project atmosphere design comprise invisible elements that may affect older people's living experience in their living room and include levels of illumination, air quality, temperature and sounds.

Furniture and furniture arrangement

For this project the furniture and furniture arrangement in the living room is defined as movable design elements that can be easily re-arranged in a living room environment, such as a chair or a table.

ONS Office for National Statistics

UNDESA United Nations Department of Economic and Social Affairs

IEA International Ergonomics Association

Chapter 1 Introduction

According to the 2011 census, 9.2 million people, or 16% of the population in England and Wales, are 65 years and over, up from 8.3 million 10 years previously (Office for National Statistics, 2013). The ONS (2018) stated that the UK ageing population has been steadily increasing from the last decade and is projected to continue increasing in the future. This demographic change has raised several challenges for the UK government including increasing costs to match the health and social care needs of the older population (ONS, 2018; HSCIC, 2014). The ONS (2018) report also indicated that as the health and social care policies tend to concentrate on curative goals, this is the area many researchers of ageing target too. Another population trend in the UK is the increasing prevalence of childlessness, which means that there are more and more people aged 65+ living alone with no support and help from children. Thus, living in a safe and comfortable home is essential for ageing people, no matter whether they want to remain in their own big house or move to a smaller apartment/flat. Therefore, retirement or assisted-living homes, designed specifically to provide a better physical environment and care service for older people, have increased in the market in recent years. Still, many older people intend to spend their later life in their own homes or change a smaller home of their own for easier management (AgeUK, 2017).

Many studies describe how existing home designs are not suitable for older people due to heightened risks in daily activities, including accessibility issues, falls, and lack of facilities for emergency situations (Severinsen et al, 2016). Therefore, some studies have paid attention to preventive solutions such as the design of care homes and new residential homes for seniors in order to better support their independence and improve quality of life (Gitlin, 2003). From design perspectives, some building design insights, such as designing an accessible bathroom or living room for older people to stay, are similar between care homes and independent homes (Chuah et al, 2016; Chamberlain and Reed, 2014; Van Steenwinke et al, 2012). However, the requirements of living room design and kitchen design for older people at home are different from care homes, as the home environment is more individualised and the design insights need to match the health conditions of each person at home (Pirker and Bernhaupt, 2011; Percival, 2002; Stones and Gullifer, 2016).

Researchers have been studying the design of an accessible kitchen for older people in the last few years (Wills et al, 2013; Hrovatin et al, 2015), but in the home environment design research

area, there has been a lack of research into older people's living room experience in the UK. The living room has multifunctional features and more complex daily activities. An unsuitably designed living room poses several risks such as collisions with furniture or tripping on a scraggly carpet (Crew and Zavotka, 2006; Pynoos et al., 1989; Clemson et al, 1996). Poor lighting and inefficient ventilation in the living room can cause psychological stress and chronic disease for older people, such as depression and dementia (Evans, 2003; Demirkan and Olgutürk, 2014; Kavanaugh, 1996; Farage et al, 2012; Maguire et al, 2014; Tsunetsugu et al, 2005; Tian et al, 2014). Thus, it is worth exploring how to improve the living room experience and to provide a safer environment for older people to stay at home.

This chapter presents the foundations for this project by briefly describing the research background, motivations, aim, objectives and questions. Section 1.1 looks at current demographic changes, the living environment for older people in the UK, and the reasons behind selecting particular living room designs with a focus on space, furniture, furniture arrangement and atmosphere. Section 1.2 explores the research motivation and lists the gaps in living room study for seniors. It presents details of research aim, objectives, questions and potential contributions of this project to older people and wider societies. Finally, the structure of this report is presented.

1.1 Research Background

1.1.1 Demographic change and living situation for older people

The demographic phenomenon of population aging is known globally (Knight, 2016). UNDESA (2015) demonstrated and projected the speed of ageing population from 2015 to 2050 in all regions of the world (Figure 1.1). Office for National Statistics (ONS, 2018) states that: "Population ageing is a global phenomenon. In 2015, there were around 901 million people aged 60 years and over worldwide, representing 12.3% of the global population. By 2030, this will have increased to 1.4 billion or 16.4% and by 2050, it will have increased to 2.1 billion or 21.3% of the global population."

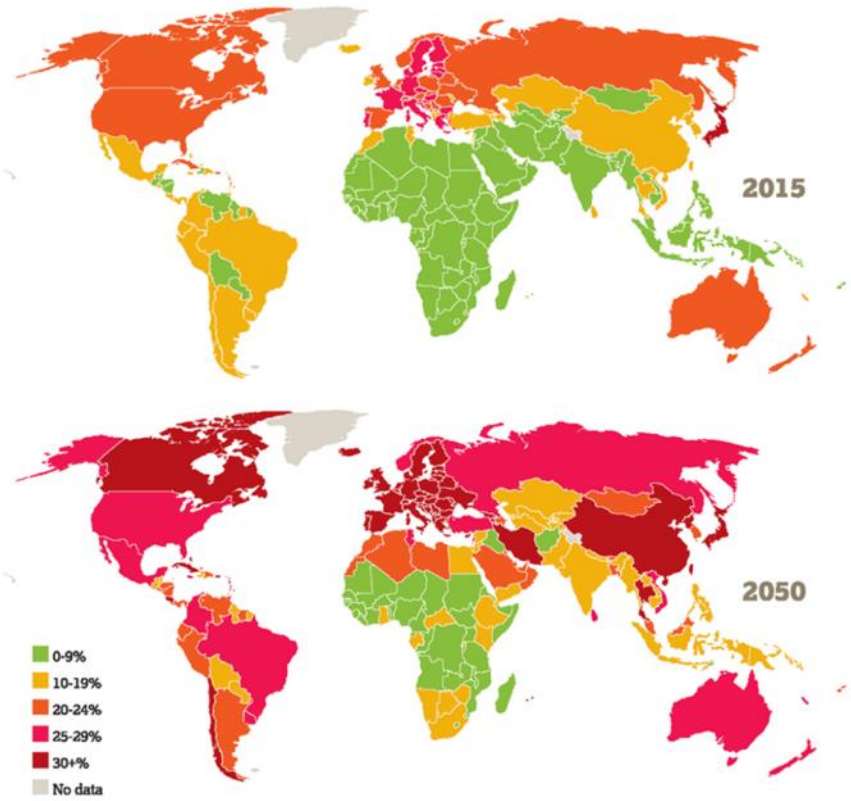

Figure 1.1 World population prospects (UNDESA, 2015)

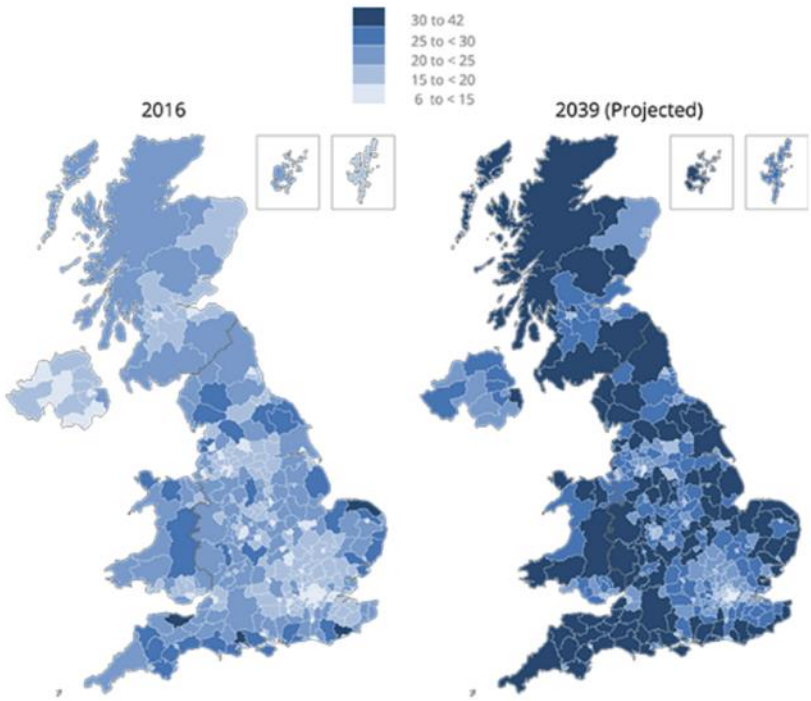

Figure 1.2 2016 mid-year population estimates for UK (Office for National Statistics, 2018)

In terms of the UK, the number of people aged 65 and over is projected to rise by over 40 per cent (40.77%) in the UK by 2040, which means nearly one in four people in the UK will be aged 65 or over (ONS, 2016). Figure 1.2 demonstrates the increasing proportions of ageing in the UK. Due to such significant demographic change, the costs for social care and healthcare have increased dramatically in the UK for older people. This includes provision of pensions and public infrastructure. Wittenberg and Hu (2015) projected that the annual costs of social care would rise from £6.9 billion in 2015 to £17.5 billion in 2035. Particularly, the healthcare home industries (such as care homes, residential homes and specialist homes) has seen a significant increase in the UK in the last decade. The number of new beds in healthcare homes has increased by 7,500 per year since 2010 (Grant Thornton, 2014).

It has been indicated that healthcare homes provide a better atmosphere for supporting mental health (Van Doorn et al, 2003; Freer and Badrakalimuthu, 2011; Lawrence et al, 2012), help avoid social isolation (NICE, 2013; Hallmark care home, 2015) and provide a safer environment for older people by virtue of their prevention strategies which reduce falls and fractures (Dyer et al, 2004). However, although the benefits of and the increasing demands for healthcare homes are notable, many researchers have argued that by remaining in their own homes, older people benefit from increased well-being and independence compared to people living in healthcare homes. In addition, keeping older people in own homes potentially reduces the cost of healthcare and social care services (Heywood and Turner, 2007, Van Doorn et al, 2003).

1.1.2 Demands for staying at home

Most older people wish to remain at home as long as possible (Severinsen et al, 2016). According to Rashidi and Mihailidis (2013), over 89 per cent of people aged 65+ prefer to spend their later life in their own homes where they have lived for many years in comfort, have good family memories and a familiar neighbourhood. The Department for Communities and Local Government (DCLD) (2008) further explained that many older people are still very keen to stay in their home because they don't want to change acquired habits in their later life (AgeUK, 2017; NDA, 2015; DCLD, 2004). Transforming from a familiar environment to a new space is more difficult for older people because the environment changes may cause them to become more vulnerable (Lawton and Nahemow, 1973). For instance, Haak et al (2007) state that home is a central place in older people's life and they become more focused on the home than younger generations. Therefore, it is essential to let older people stay at home,

giving them the freedom to live in a familiar neighbourhood with memories of their life while maintaining as much autonomy as possible (Wiles et al, 2011; Katz et al, 2011; Dahlin-Ivanoff et al, 2007; Haak et al, 2007).

As older people demand to stay at home, most of the research on older people tends to focus on health and social care provision (House of Lords, 2013). However, health and social care policies tend to concentrate on curative purposes and a very few studies and policies have paid attention to preventive measures such as the design of home environments for older people in order to improve their independence and quality of life. For instance, in the policy field, the government used the British building regulation 'AD Part M' and '16 design criteria of lifetime homes' criteria to help improve access and use of new builds for disabled people. Considering the principle of flexibility in use, several studies have contributed to structural changes or home modification and assistive technology to cater for the wellbeing of older people via new product design and development. These new interventions have developed new products, services and environments addressing the needs of the widest number of consumers, including older people (Seidel et al, 2010). Although the existing research findings are useful and an increasing attention has been given to exploring older people's needs in various spaces, inclusive housing design is still at a conceptual level in England and there is lack of evidence in people's needs towards inclusive home environment design and its implementation.

The majority of first-time home buyers are aged between 25 and 35 years (Bernard, 2015). This could stem from the mortgage rules in England that are discouraging homebuyers aged 35+ as the down payments in the final years of a 25-year or long-term mortgage would fall into retirement age. Due to the ageist perspective created by the major lenders in the country, most first-time homebuyers tend to be younger people. When these young families age, the home environment does not cater for their needs and expectations especially due to increasing disability and chronic conditions in later life (Nelson, 2013); For instance, the internal home design and layout may not be flexible enough to accommodate mobility devises such as scooters and wheelchairs (Huffman, 2014). This could consequently impact independence and quality of life for older people living independently through falls and injuries, the most common home hazards (Renaut et al, 2015). Age UK (2015) highlighted falls at home as the biggest threat in the home environment, leading to up to 40 per cent of ambulance call-outs among people over 65. Therefore, to live in a suitable and risk-free environment in later life,

3% of households with older people move to specialist housing (with special facilities and design features) per year (Pannell et al, 2012).

1.1.3 Older people's living situation in the UK

The author used the 2011-2012 English Housing survey (refereed to here as EHS2012) from the UK Data Archive (UKDA) to understand the current housing situation in the UK. The EHS is a national survey of the physical conditions of housing stock in England. In addition to collecting data on household type, age and the socio-economic characteristics of the householders, the survey included the Housing Health and Safety Rating System (HHSRS) to assess potential risks to health and safety in the properties. Moreover, the dataset also includes information on disability, adaptations, and detailed information on housing characteristics. Unlike previous housing surveys, this dataset does not include actual risks including falls. Data on a sample of around 14,386 households were collected between April 2011 and March 2012 (by using face-to-face completed questionnaires method). As the recent EHSs did not collect information on adaptation of housing, our analysis is restricted to the latest data available that is the English Housing Survey 2011/12 (UKDA data set reference number 7362). The final analysis is based on household and individual data to take into consideration household attributes and home environment. Therefore, the sample size reflects the demographic characteristics of England including the female advantage in life expectancy. Moreover, EHS also helped provide a better understanding of the English housing characteristics from the perspective of dwelling types and the demographic shift.

To understand the factors of the housing characteristics in England and their impacts on older people's living environment at home, the author analysed EHS data by using statistical analysis methods via SPSS software.

Based on the EHS data, dwelling type has been divided into the following five categories: terraced houses (including end terrace and mid terrace), semi-detached houses, detached houses, bungalows, and flats (including converted flat, purpose built flat, low rise and high rise). Table 1.1 shows that the majority of people aged between 60-69 live in semi-detached houses and terraced houses and a majority of people aged between 70-79 live in semi-detached houses and bungalows. Also, a significant proportion of people aged over 80 live in bungalows and flats. It is likely that at the age of 80 older women might downsize their property and move

into purpose-built flats from a health and well-being perspective. Nearly 66% of young older people live in terraced, semi-detached or a detached house.

Table 1.1 Type of dwelling by the age of the household reference person (%)

	16-29	30-39	40-49	50-59	60-69	70-79	80-95	Total
Terraced House	*38.1*	*38.0*	*33.1*	*26.6*	*23.6*	*17.6*	*16.9*	*28.9*
Semi-detached House	*17.5*	*26.1*	*29.3*	*26.9*	*23.9*	*23.4*	*18.0*	*24.7*
Detached House	*1.9*	*8.0*	*15.5*	*20.2*	*18.6*	*14.5*	*11.3*	*13.6*
Bungalow	*1.5*	*2.0*	*3.6*	*7.5*	*14.7*	*23.0*	*24.4*	*9.3*
Flat	*41.0*	*25.9*	*18.5*	*18.8*	*19.2*	*21.5*	*29.5*	*23.5*
Total	1,564	2,463	2,905	2,395	2,360	1,702	997	14,386

Couples with no dependent children are likely to live in terraced, semi-detached or detached houses (Table 1.2). Bungalows are preferred by couples with no dependent children or older people aged 60 and above. Flats have a very heterogeneous type of living as they are preferred by all types of households to an extent. Older people, mixed multi-person households and lone parents with dependent children reported higher proportions of flat residence compared to other household types.

Table 1.2 Household arrangement by dwelling types

	Terraced House	Semi-detached House	Detached House	Bungalow	Flat	Total
Couple, no dependent children	*23.8*	*26.9*	*21.2*	*13.0*	*15.1*	4,585
Couple with dependent children	*35.2*	*31.7*	*19.0*	*2.2*	*12.0*	3,152
Lone parent with dependent children	*44.4*	*28.1*	*3.1*	*1.8*	*22.6*	1,431
Other multi-person household	*39.0*	*24.8*	*8.0*	*5.3*	*22.9*	1,107
One person under 60	*25.0*	*13.3*	*4.7*	*6.1*	*51.0*	1,824
One person aged 60 or over	*18.9*	*17.6*	*7.6*	*20.6*	*35.3*	2,287
Total	*28.9*	*24.7*	*13.6*	*9.3*	*23.5*	14,386

The later part of the analysis looks at the risk assessment in relation to health.

Table 1.3 Levels of risks of falls by age group

	16-29	30-39	40-49	50-59	60-69	70-79	80-95	Total
Falls on the stairs								
Lower than average risk	*7.1*	*7.5*	*9.1*	*14.4*	*22.8*	*23.2*	*16.0*	439
Average risk	*10.8*	*17.2*	*20.1*	*16.6*	*16.4*	*11.8*	*7.1*	12,059
Higher than average risk	*12.4*	*18.9*	*23.4*	*17.2*	*15.0*	*9.2*	*3.8*	1,888
Falls on the level								
Lower than average risk	*5.0*	*0.0*	*0.0*	*10.0*	*20.0*	*40.0*	*25.0*	20
Average risk	*10.8*	*17.1*	*20.1*	*16.6*	*16.5*	*12.0*	*7.0*	13,428
Higher than average risk	*11.7*	*18.6*	*22.2*	*17.4*	*15.4*	*9.6*	*5.1*	938
Falls between levels								
Lower than average risk	*8.0*	*9.9*	*9.1*	*12.9*	*20.1*	*27.7*	*12.5*	264
Average risk	*11.0*	*17.3*	*20.2*	*16.6*	*16.3*	*11.6*	*7.0*	12,893
Higher than average risk	*10.3*	*17.3*	*22.1*	*17.8*	*16.6*	*10.9*	*4.9*	1,229
Falls associated with bath								
Lower than average risk	*3.9*	*7.8*	*9.7*	*14.1*	*17.5*	*29.1*	*18.0*	206
Average risk	*11.0*	*17.3*	*20.3*	*16.7*	*16.4*	*11.5*	*6.8*	13,892
Higher than average risk	*9.4*	*17.4*	*20.8*	*16.0*	*16.0*	*14.9*	*5.6*	288
Total	1,564	2,463	2,905	2,395	2,360	1,702	997	14,386

Table 1.3, illustrating risks at home by age, shows that households with younger people aged 30-39 and 40-49 are likely to have a higher risk as they have not made any adaptations and these households are likely to include children. For ages 60 and above, we see that higher than average risk of falls ranges between 4 and 15%. As households with individuals aged 70 and above either live in one level households (bungalows/flats) or in two-level households that have made appropriate adaptations to avoid risk of falls, we see that the risk declines among older people aged 70-79 and 80+. It is important to note that 17% of older people aged 50-59, 15% of older people aged 60-69 and 9% of older people aged 70-79 continue to live-in high-risk households for falls. Falls on the level, between levels and falls associated with the bath have similar trends with varying levels. A large proportion of households with older people live in average and higher than average risk households especially between 50 and 70 years of age. Though a high proportion of people aged 30-49 live in high-risk households, we argue that the impact of risk increases with age and hence designers need to take into consideration needs of families as well as older people.

Table 1.4 Disability and health situation by age

	16-29	30-39	40-49	50-59	60-69	70-79	80-95	Total
Long-standing illness by age	*4.9*	*9.0*	*15.4*	*19.6*	*21.9*	*16.6*	*12.7*	2,495
Whether it limits activities by age	*4.2*	*8.3*	*14.6*	*20.3*	*22.5*	*16.3*	*13.8*	1,576
Registered disabled by age	*2.8*	*4.9*	*11.8*	*21.4*	*24.0*	*17.7*	*17.5*	576

Table 1.4 shows that illness increases from age 16 to 69 steadily. From age 70, we see a decline in illness due to mortality bias. It is likely that people with long standing illness are likely to have shorter lifespans creating this inverse association. The majority of older people aged 50-95 reported that their activities are limited due to their illness. Disability also increases with age up to age 70. Based on this, we argue that the impact of risk will be higher among people aged 50 and above. Moreover, evidence shows that falls are the most common cause of injury related mortality for aged 75 and above (NHS, 2015). Hence, designers need to take into consideration risks that occur in older people as the impact of accidents and injuries increase with age.

The analysis also considered response to need for adaptations and various adaptations that are relevant for health and well-being. Table 1.5 presents adaptations required as well as made on stair rails and stair lifts. The results clearly show that the likelihood of adaptations being made increases by age for both the adaptation measures. However, the need for adaptation shows an increase in need up to age 79. The need for adaptations declines for ages 80-95 as a majority of them live in flats and bungalows. Some older people living in two-level high-risk houses have carried out necessary adaptations. As the adaptation questions were restricted only to high risk households, it is difficult to assess the need of adaptations in average and low risk households and to identify gaps in the households that might be confronted with higher risks in the future.

Table 1.5 Implementations and needs of home adaptations by age

		16-29	30-39	40-49	50-59	60-69	70-79	80-95	Total
Adaptation of grab/hand/stair rail	*Has*	*0.3*	*3.3*	*8.6*	*18.6*	*21.0*	*23.1*	*25.2*	338
	Needs	*1.7*	*4.8*	*9.6*	*20.3*	*23.7*	*20.6*	*19.2*	291
Adaptation of stair lift	*Has*	–	–	*11.8*	*16.2*	*7.4*	*23.5*	*41.2*	68
	Needs	–	*1.9*	*13.0*	*25.9*	*14.8*	*18.5*	*25.9*	108

Through the EHS dataset analysis, it has been confirmed that dwelling type is one of the most important factors that has a great impact on older people's living situation in the UK. Dwelling type may be divided into house (two or more storey house), bungalow (one storey house) and flats (Peace and Holland, 2001; Peace et al, 2005). HATC (2006) reported that houses normally have a larger living room and more functional rooms to use than flats. It also showed that houses have more accessible and circulated paths in their living rooms to avoid obstructions for elderly people. Additionally, the floor level of the living room affects the elderly's mental health and well-being. For instance, research indicates that a higher-level flat could cause

anxiety in older people (Evans, 2003). Due to the differences of dwelling types, older people may have different experiences in their living room when doing daily activities. Older people's living room experiences are relevant to their dwelling age and dwelling maintenance. Therefore, dwelling types must be considered when observing older people's living room experience. This is also one of the key factors in the conceptual framework (details shown in section 2.6).

1.1.4 Risks at home

According to the EHS data analysis results, it is clear that although older people are keen to stay at home, researchers have indicated that many existing home designs are not suitable for them in later life due to potential risks in daily activities, such as accessibility issues, falls and lack of facilities for emergency situations (Severinsen et al, 2016). The risks of living independently at home are caused by changing human factors, such as mobility, vision and body flexibility and the poor housing conditions of their current home.

From the human factors' perspective, impaired physical mobility means the living environment is not always fit for older people's needs and expectations. With age increasing, older people become progressively less mobile and less able to adjust to their reduced mobility (Metz, 2000; Arthur et. al., 2009). Visual impairment might also stop them carrying out certain daily tasks (Percival et al., 2003). From the housing conditions perspective, Garrett and Burris (2015) indicated that one in five homes (21%) occupied by older people in England had not reached a suitable design standard (around 2 million households). The poor living environment could further deteriorate people's physical and mental health, particularly for those who limit their physical activities (Henning-Smith, 2016; Halpern, 2014). Moreover, they might suffer a feeling of social exclusion and isolation (Greenfield and Russell, 2011; Klinenberg, 2013), as well as depression and anxiety (Li et al., 2011). Thus, poor housing conditions could cause serious problems and risks for older people's daily activity and independence (Haak et al, 2007). Though many older people understand their living environment at home may not suitable for them to stay in their later life, it can be difficult for them to move to a better living environment. There are two main reasons for this: 1) the rising cost of care home fees in recent years is unaffordable (Elder,2008); and 2) private pensions income dropped in recent years (Beioley, 2017). Local authority assistance may help older people's financial situation, but most of them still need to sell their own home to move, which may have a bad impact on the wider family (Elder,2008).

Because of such home-related risks and hazards, researchers and designers have developed various solutions and strategies for improving the home environment for older people. Home environment design related studies have focused on kitchens (Maguire et al, 2014), bathrooms (Chuah et al., 2016; Chamberlain et al., 2011; Quitzau and Røpke, 2009), or bedrooms (Booranrom et al., 2014), but very few of them have discussed the living room. The living room has been identified as one of the most frequently used spaces for older people. It is multifunctional, but there are risks that the occupant may not be aware of. Importantly, researchers need to explore the living room experience, how it impacts day-to-day life, and investigate the risks and challenges that older people face (Saruwono et al, 2012).

1.1.5 Importance of the living room

There is no doubt that the living room is an essential area to a family and represents a host's personality and social identity to guests (Pirker and Bernhaupt, 2011; Rechavi, 2009),. This is especially true for older people. Numerous researchers have explored the history of the living room and indicate that the living room is one of the most important areas in the home where people gather and enjoy leisure activities (Pirker and Bernhaupt, 2011; Rechavi, 2009). For family members in the same household (partner, spouse or children living in the same house), the living room is an important space for them to share time together. Older people sometimes utilize the living room as a private area for individual activities like reading and writing (Rechavi, 2009). The living room also provides opportunities for all household members to engage in activities together (Rechavi, 2009; Mitton and Nystuen, 2016): watching television, talking about their day and playing games may all occur here. Such positive activity engagement and good relationships within families directly contribute to older people's health and well-being (Mendes de Leon et al, 2003; Law et al, 1998).

For older people's socialisation, the living room is an important venue to connect with relatives and friends from outside the household. Older people demand more socialisation activities (Wiles et al, 2011; Saruwono et al, 2012) and they frequently invite relatives and friends to visit them and arrange events at home (Hanson et al, 2015). Singh and Misra (2009) investigate the relationship between depression, loneliness and sociability with older people and emphasise that sociability plays an important role in preventing mental problems and enhancing well-being.

Nowadays many older people have moved from the kitchen to the living room to eat while watching the television, to make eating more interesting. Older people may rely on ready meals and convenience food to keep them fed (Swerling, 2019). Whitelock et al (2018) explained that one of the reasons for this reliance on ready meals was eating alone. This has affected older people's dietary behaviour in the UK, as some older people lose the incentive to cook and eat for themselves. Geissler (2018) reported that there has been a shift in the eating habits of people in the UK as people have migrated from the dining table to the sofa to watch the news and other television programmes. Geissler (2018) calls this the 'digital dinner table'. Geissler (2018) argues that this can actually boost the meal experience, as watching and discussing the news during eating can add richness to meal times, and can also make older people not feel like they are eating along. Moreover, some older people may have mobility issues or chronic pain that makes them eat on the sofa (AgingInPlace, 2020). There are a variety of trays on the market to assist older people in their daily life that include, lap trays, carrying trays, insulated trays and slip resistant tray liners, but these trays may not to support them whilst eating meals on the sofa （Geissler, 2018). For example, the tray surface may be too slippery to keep the dishes stable on the tray when older people place the tray on their lap.

Therefore, the living room provides a multifunctional space for UK older people's day-to-day life, whether socialising or for private usage. Different activities require different furniture arrangements to suit these differing needs (Saruwono et al, 2012). Weening and Staats (2010) confirmed the positive impact a living room refurbishment can have on older people's physical and mental health. Weak illumination and bad ventilation in the living room could cause psychologically stressful and chronic diseases for older people (Evans, 2003; Demirkan and Olgutürk, 2014; Kavanaugh, 1996; Farage et al, 2012; Maguire et al, 2014; Tsunetsugu et al, 2005; Tian et al, 2014). Hence, living room environment design has an essential connection with older people's health and well-being.

1.2 Research Gaps

Although the living room is an essential feature of older people's lives, lack of study in this area means research gaps still remain.

1) Many studies on home environment design focused on how to develop new houses or new retirement villages for older people in the UK (GOV. UK, 2015). But many older people cannot afford these and still need to stay in their current home. Few studies have

discussed how to improve the current living environment to provide sufficient living and caring support for older people that allow them to stay in their original home as long as they want.

2) Moreover, numerous studies in inclusive design research concentrated on the function room of kitchen and bathroom, such as ergonomic kitchen design for older people (Maguire et al, 2014) and user-friendly bathroom design for older people (Chuah et al., 2016; Chamberlain et al., 2011; Quitzau and Røpke, 2009; Gitlin et al, 1999). Furthermore, current research also concentrated on product design for older people at home, such as assistive lighting for people with sight loss (Fisk and Raynham, 2014), and preventing falls by home-based technologies combined with a monitoring assistive centre (Tchalla et al, 2012). There is a paucity of research that has explored older peoples' living room design at home and the interactions with the living room spaces, products in the living room and people in the living room.
3) From an ergonomics design aspect, a great deal of research focused on the functionality and usability of home modification and adaptive devices. However, relationships between product and environment were neglected from most of these studies, especially how the products have been used under different activities and circumstances in a living room in an older person's home.
4) Moreover, the existing home environment design has focused more on other countries, such as New Zealand, The Netherlands and Denmark. Furthermore, the ageing situation was researched many years ago, but the living habits and behaviour of older people in the UK have changed in recent decades. Therefore, the living room environment design for older people in the UK cultural context requires new research.
5) Many researchers have highlighted health and safety risks and barriers in the home environment associated with older people (Gitlin et al, 2001; Lord et al, 2006; Fänge and Iwarsson, 2003; Iwarsson, 2004; Iwarsson, 2005; Stark, 2004; Wahl et al., 1999). In response to this, in recent years numerous housing planners, commissioners and designers have considered the special needs of older people with physical and mental health issues and focused on inclusive design for improving the home environment for an ageing society (CABE, 2009; Williams, 1990). Also, the EHS study suggests that the majority of older people's homes still have risks as they have limited inclusive design features due to lack of knowledge, monetary or time constraints. Therefore, in terms of the application of inclusive design in older people's current homes there is still a long way to go. It needs the researchers, designers, housing planners, commissioners,

and other stakeholders to work together to develop and promote low cost and ageing friendly home design for older people.

1.3 Aim, Objectives and Research Questions

Due to aforementioned research gaps and with the intention of *improving* older people's living room experience, this investigation explores the experiences of older people in their home living room. In particular, the study identifies the risks and challenges older people face in their day-to-day lives and develops design insights for improving living room space design, furniture and furniture arrangement, and atmospheres design. These design insights can be used to improve the home living room environment for older people in the UK.

In order to achieve the research aim, four objectives and three research questions are considered. The research objectives are to;

1) Study the home living situation and conditions of older people in the UK through the English Hosing Survey 2012.

2) Investigate older people's living experience with their living room at home in the UK.

3) Identify the challenges and needs that older people face in their living room at home under different scenarios and analyse the reasons behind these challenges.

4) Develop design insights and recommendations for improving living room environment design for older people in the UK.

Research questions:

1. How do older people currently use their living rooms for different activities and purposes?
2. To what extent do older people experience challenges and hazards in their living rooms?
3. How can we improve the living room environment for older people in the UK through better inclusive design?

1.4 Contributions and application of this study

The main contributions and applications of this study can be summarised as the following:

This is the first study to focus on older people's living room design in the UK. The systematic view of how older people used their living room and the consideration of their unmet needs highlights the importance of exploring relationships between space, products and older people in the living room environment. For example, a well-designed ergometric table may not be suitable for older people in their living room due to limited space availability. The results of this study develop coherent living room design insights that will a) help interior designers, architects and service providers to enhance their thinking of design and develop details in the current design guidelines for older people's living room design; b) provide inclusive design insights that are interlinked with other formats of older people's living environment. Thus, no matter whether for residential home design or new care home design, it will give interior designers, architects and service providers new inspiration; c) help interior, architect and service design industries to find out business opportunities and how they could provide new services of tailored home design for those richer older people.

This study provides a theoretical framework that can be used as a reference system for a systematic analysis of older people's needs toward product types (such as sofa or tables) in the living room (or even other functional rooms). It will help designers and researchers to understand relevant factors for older people's needs and develop appropriate products for older people to use.

This study provides an effective tool to understand older peoples' living room experience. It can be applied in other ageing-related research areas to explore older users' experience and behaviours, such as an ageing-friendly hospital or care home design. It also provides insights for designers and researchers in methodology innovation in the related research field.

This project also helps policymakers to develop a better understanding of older people's living situations and their unmet needs. The design insights can help the policy maker to develop new home design criteria for older people. Moreover, the design insights of this study could also be used to spread knowledge through newspapers or charity fliers to let older people themselves, their children or other relevant acquaintances, to understand the importance of inclusive design and how to make a safer living environment for older people. The study a) helps older people

know how to protect themselves at home and may motivate them to make adjustments to their home and also b) brings opportunities to business.

This study provides the living room design insights that could be used for interior designers, architects, service providers, researchers and policy makers to give them inspiration and new design ideas for the ageing society. To apply the design insights to the ageing society, designers, policy makers and stakeholders need to work together to address home environment design in a consistent way. Interior designers, architects and service providers need to consider their profit when providing new design and services. Though there are affluent customers that can afford the expense of improving their living environment, most older people cannot afford the high price of the new homes and new products, even if they are designed to be ageing friendly. So, when designing new homes and products there needs to be a consideration of the balance between the cost and affordability. Policy providers must also support businesses working on design ideas for older people, such as giving them support or reducing tax. Design for ageing is not just a design issue, but also a social, economic and political one.

1.5 Structure of the thesis

This section outlines the structure of the PhD thesis through the following chapters:

Chapter 1: Introduction. This chapter describes the background, motivations, and significance of this research. In addition, it states the research aim and outlines the specific research objectives.

Chapter 2: Literature review. This chapter provides an in-depth review of the existing research. More specifically, and according to the research aim, it presents a literature review in three main research areas: age-related changes of older people, inclusive design, and age-friendly and ergonomic products. Moreover, the author discusses the relationship between space, product and people.

Chapter 3: Methodology. In order to achieve the research aim, a mixed research methodology utilising an ethnographic approach is adopted in this study. This chapter provides details on the research methods employed to answer the research questions followed by detailed description of data collection and data analysis methods.

Chapter 4: This chapter, the first of the findings chapters, presents space relevant issues for older people in the living room. This includes 1) size and structure of the living room 2) flooring design of the living room 3) wall design of the living room 4) the issues with the living room door 5) window related problems, and 6) issues related to sockets and switches. Moreover, design insights are suggested after the discussion of each finding.

Chapter 5: This chapter presents furniture relevant issues for older people in the living room. This includes 1) lighting related issues, 2) furniture design and furniture arrangement, and 3) decoration elements in the living room. Meanwhile, after discussion of each finding, the author gives a list of the design insights.

Chapter 6: Summary of the project, research contributions, limitations and future research direction.

References

Appendix

Chapter 2 Literature review

2.1 Introduction

The previous chapter discussed the background of this research, describing the research motivation, outlining the research aim and objectives, addressing research contributions and explaining the research structure. This chapter presents a literature review covering key theories on age-related changes of older people, inclusive space and product design, and the interaction between space, product and people, so as to build a theoretical foundation for this research. The principles of inclusive space and inclusive product design are two useful approaches for this project. This is because ageing bodies have different needs to other groups of users and it is essential to focus on inclusive space and product design to minimise risks and hazards in the home. Inclusive service design, related to home service for older people, is not covered in this study.

Section 2.2 explains literature that relates to functional changes associated with ageing. Sections 2.3 presents the home environment for older people. Section 2.4 presents the concept of inclusive design, with inclusive space design and inclusive product design. Section 2.5 discusses the interaction between space, product and people. Section 2.6 confirms the research scope and presents a conceptual framework for this study. The research gap aim and objectives will show in section 2.7.

2.2 Age-related changes of older people

Definition of older people: in this project 'older people' refers to individuals aged 65 and over. The World Confederation for Physical Therapy (WCPT, 2020) indicated that older people might be defined by a range of characteristics, such as chronological age, change in social role (such as retirement) and change in functional abilities (such as disability). Moreover, the elderly population is normally defined as people aged 65 and over (OECD, 2018). In addition, as most research studies on older people (they might also be called the older generation, baby boomers, seniors, or aging groups) use 'older people' as one broad group it isn't clear how other characteristics such as social life or bodily abilities intersect with age. Therefore, for this project, the author will use the terminology of older people as a general definition of an older person aged 65 and over. This covers all social role and body functional abilities.

Due to older people's changing physical and psychological needs, they have more requirements than the younger generations in order to allow them to live independently and maintain well-being at home. As age increases, an older person's body experiences decline in sight function, hand function, body mobility, balance, and memory (Farage et al, 2012). These changes can affect older people's living ability in a physical environment (Pinto et al, 2000; Schmall, 1991) like the living room at home, which leads to difficulties doing daily activities or everyday household tasks. As previously discussed in section 1.1.2, people do not necessarily want to move out from their home to a care home when they get older. One of the biggest challenges older adults face is that the previous housing design may not satisfy their requirements for independent living in their later life. The following sections are based on the current knowledge of people's age-related functional changes and how these changes could affect their ability for daily activities in the living room at home.

2.2.1 Changes in sight function

Sight function changes with increasing age. In the UK, 20% of people aged over 75, and 50% of people over 9, have a visual impairment (Rotheroe et al., 2013). Research shows that visual impairment issues among older people can be classified into a) decreasing visual acuity (e.g. near-focus or presbyopia), b) decreasing contrast sensitivity (Sinclair et al., 2014), c) difficulties with glare and low light (Pattison and Stedmon, 2006; Schmall, 1991) and d) age-related loss of colour perception (Johnson et al, 1988).

These visual impairment issues can cause many limitations in mobility, balance, and activities for daily living (Salvi et al, 2006; Sinclair et al, 2014; Salive et al, 1994; Tobis et al, 1985). For instance, Brawley (2008) reported that up to half of all nursing home residents in San Francisco had difficulty navigating around their home environment because of vision problems. In recent decades, this has been identified as a common scenario throughout the globe. Moreover, sight loss might affect old people using the living room to read letters or newspapers, doing hobbies (TV, knitting and sewing), communicating with others (telephone, writing letters, recognising friends, risk of social isolation), and affect movement in the living room (e.g., cannot see holes and barriers on floor) (Gibbs et al, 2004).

In terms of the home environment design, various research has argued for the importance of lighting system design that includes natural light and artificial light, and the requirement of lighting system design of older people (Agrawal, 2017; Hrovatin and Vižintin, 2013; Loh and

Ogle, 2004). In term of natural light, it has been highlighted that older people's eyes feel more comfortable under natural light doing various daily activities during the day, including reading and sewing (American Optometric Association, 2006; Barnes and Design in Caring Environments Study Group, 2002). There is no doubt that natural light is influenced by the design of the window in the living room. Meanwhile, the layout of the furniture also impacts on how older people gain natural light. Some interior designers have suggested how to layout furniture in the living room around windows. They considered the best usage of the space, meanwhile, considering the most efficient way to use the natural light to do daily tasks in the living room, such as where to allocate the sofa to have the most efficient natural light for reading during day time (Ching and Binggeli, 2017). However, these guidelines are used for normal people and general usage, whereas older people have specific concerns when laying out their furniture for natural light.

Moreover, as visual acuity and sensitivity to contrast decline, older people need strong contrasting colour to distinguish two surfaces (such as floor and baseboard or furniture) to protect collisions or falls (Crew and Zavotka, 2006). Therefore, colour has been highlighted as one of the most important elements of home design for older people to remain independent (Crew and Zavotka, 2006; Rowles et al, 2003; Maisel, 2006). Moreover, colour also affects older people's mood. Weenig and Staats (2010) examined people's moods and emotions as influenced by colour. The authors indicated that the red colour had 'warm' feelings and blue colour had 'cold' feelings. This not only affects older people, but also has an effect on all generations (Smith et al., 1990), however as older people spend a lot of time in the home, it is particularly important for this group. Therefore, the use of colour in the living room has a psychological influence on older people and their wellbeing.

2.2.2 Changes in hand function

The functional movements of hands and fingers decrease with age, and these influences older people in the way they do daily activities. Age-related degenerative changes in hand motor function include decline in handgrip/pinch strength, pinch control, and sense of touch (Carmeli et al, 2003; Wickremaratchiand Llewelyn, 2006; Haigh 1993), directly affecting physical activity and quality of life of many elderly (Lenardt et al, 2016). For example, hand joint pain and stiffness make it difficult to grip and hold various surfaces (Farage et al, 2012), such as turning a knob or opening a cap. It also means older people have less strength to use keys or

buttons (which need precision), have lack of control over sequence of movement (opening a package or typing), and experience challenges to grasp handles or handrails (Farage et al, 2012).

Facing this age-related change, researchers and designers have suggested how to design and select appropriate furniture handles and door handles for older people (Jonsson, 2013; Hrovatin and Vižintin, 2013; Seidel et al, 2010). However, there has been limited research to study how to design furniture for easy and safe moving by older people at home.

2.2.3 Changes in body movement function

Quality of life in old age is also related to mobility (Metz, 2000; Fisk et al, 2009). As people get older, muscle strength declines and flexibility reduce (Kalyani et al., 2014). Mobility changes can present physical challenges for living independently (Metz, 2000) and unsuitable living environment design might cause safety issues for older people (e.g., stairs present a high risk at home) (Barker and Nicholson, 2003). Due to their physical limitations, older people become progressively less mobile and less able to adjust to their reduced mobility (Arthur et. al., 2009). The daily life of a person might be restricted to the house, a room, or even a bed, and autonomy is reduced. Moreover, balance is another important issue among older people (Newton, 2003). Due to reduced ability of body balance, older people might have a fall when bending, stooping or stretching. Furthermore, visual impairment, declined hearing, muscle weakness, and reduced mobility could cause loss of balance and present risks for living independently at home, where falls and collisions are exacerbated by unsuitable furniture placements (Mowé et al., 1999).

Previous research also confirms that reduced body movement for older people limited the control of their bodies, such as creating difficulty transferring from wheelchair to armchair, or losing body balance when bending, stooping and stretching. (Czaja et. Al, 2019; Metz, 2000). Due to these changes, researchers suggest using ergonomically designed products and furniture at home (Blackler et al, 2018; Hrovatin et al, 2015; Pinto et al, 2000; Farage et al, 2012), such as ergonomic seating and chair with self-raising functions, which could help older people stand up and move from their chair to another place.

The term ‘ergonomics’ has been defined by researchers as the study of human characteristics for designing appropriate working and living environments to support health and wellbeing (Elbert et al, 2018). Ergonomic design covers product and system design that relates to workspaces, sports and leisure, health and safety. For this research project, ergonomic design

is focused on products related to older people's living rooms, For instance, adjusting furniture to suit the needs of older people, such as lowering of cabinets (Hrovatin, 2012), and a wide range of low and high technology devices that have been developed to help older people in the home, such as for preventing a fall (Bouma et al, 2000). The study of ergonomic chairs was discussed in detail by a group of researchers recently via an ethnographic approach (lackler et al, 2018), however, they only focused on the chair design itself and how it interacted with older people. Interaction with other products and interaction with the space was not covered.

Therefore, there is no doubt that ageing accentuates problems in the living environment. These limitations hamper daily activities and lead to risks and challenges when older people interact with others and with the physical environment. Independently living at home in later life is more challenging for older people, necessitating a reassessment of their capabilities. It also requires more thoughtful design solution/ guidelines to help older people stay at home as long as possible. Researchers and designers need to consider physiological changes to give better solutions for older people's independent living. To satisfy this demand, inclusive design has been developed to improve older people's health and wellbeing. This will be discussed in the following section 2.4

2.2.4 Psychological changes

As people grow older, they are not only faced with physical changes to their body, but also psychological changes that affect their capacity to live independently and happily at home. Previous literature has confirmed some of the requirements and consideration points of the home design based on older people's psychological changes, including sense of security, sense of identity and needs of social communications.

In terms of sense of security, lots of researchers have confirmed older people's intention of living independently at home (Oswald et al, 2007; Stones and Gullifer 2016; Ziegler and Schwanen, 2011). Hillcoat-Nallétamby (2014) studied the understanding of older people's sense of "independence" from 14 themes. From previous ageing studies, it was also highlighted that older people desire to retain a sense of self determination and personal control and autonomy (Peace et al, 2011; Evans,2003). Dahlin-Ivanoff et al (2007) state that "home means security and home means freedom". In terms of the sense of security, from the user study, it found that single women living independently at home had a lower sense of security than single

men and couple households so for this group there are negative psychological impacts of living at home alone.

In terms of sense of identity (also called the sense of freedom), to live independently at home allows older people to show their own self-identity (Altman and Low 1992). Rechavi (2009) studied the different usages of the living room between private and public. He indicated that the decorative items in the living room directly show the homeowner's self-identity and self-taste. Older people's requirements of home atmosphere design via decorative items (such as usage of colour and lights and meaningful decorative items), can give them a positive mood to evoke their personal emotions. However, it could also be found that if displayed in a messy way, the decorative items might cause tripping hazards and made the cleaning process more complex. From the interior design perspective, there is some research giving tips on how to display decorative items in the living room, however, the tips are more suitable to the younger generations and modern home design style, and less appropriate for older people. Therefore, how to display items in the living room for older people needs further consideration.

In terms of social communication needs, Singh and Mishra (2009) demonstrated that positive social relationships play an important role in enhancing older people's health and well-being. Croucher et al (2007) confirmed that social relationships can enhance a sense of belonging for older people. The living room has been defined as a functional room to entertain family members and guests (Rechavi, 2009). The design style and furniture arrangement of the living room could cause different physiological responses to homeowners and visitors (Tsunetsugu et al, 2005). In terms of older people's living room, the need to select the most important and functional furniture to make living room space as large as possible has been discussed, as older people need more empty space because they might need to use a walking frame in the living room. In addition, the living room is a private space to use when staying at home by oneself (Saruwono et al, 2012). The size of the living room might limit older people's ability to entertain friends. In terms of design practice, Ikea have lots of good ideas and design solutions for small sized living rooms that can transform a small space into different functional spaces with "foldable, flexible, stackable, movable and climb-up-on-top-able furniture" (Ikea, 2019). However, in terms of older people's living rooms, there are not design solutions covering this area. Considering older people's needs, especially for those living in small spaces, it is necessary to design a multi-functional living room to fit older people's age-related needs

2.3 Home environment design for older people

The author's initial literature review encompassed all home environment design and interior design as the key field for this project. The reason for a broader search term (i.e. not only focusing on literature on older people) was to gather comprehensive information and foundational design theories. The author then continued to study inclusive design and ergonomic design subjects focused on older people. The following literature covers research that focuses on home environment and inclusive design for older people at home.

Some researchers use the term 'Environmental Gerontology' as a conceptual framework for studying the home environments of older people (Renaut et al, 2015). 'Lifetime Home' and 'Aging in Place' are two popular terms used to consider older people's health and safety in the home. Over the last decade, these concepts have increasingly gained recognition by the UK housing policy and new house building industry for older people (Madeddu et al, 2015).

From a theoretical perspective, the key factors of home environment design have been highlighted in various studies. Evans (2003) indicated nine environment factors that could affect people's mental health (effecting all generations, including older people). These are; 1) provision of safety within existing risks at home; 2) residential floor level for those who lived in flats; 3) comfort related to maintenance of thermal and humidity levels; 4) furniture arrangement at home; 5) provision of privacy; 6) noise levels; 7) indoor air quality and air velocity; 8) lighting systems and 9) the surrounding environment including neighbourhood quality. To update this schema for the older generation, Demirkan and Olguntürk (2014) added more details on inclusive accessories in home environment for older people, such as changing to easy-grab cabinet handles and easy-twist faucets. These environmental design parameters have been confirmed by other researchers as having a significant effect on older people's safety and comfort (Mohammad et al, 2014).

From a practice perspective, to improve older people's home environment, design criteria have been applied to 'AD Part M' (Table 2.1) and '16 design criteria of lifetime homes'(Table 2.2) regulations to make sure future housing design by building contractors in the UK is inclusive of disability needs and ageing-friendly (HM Government, 2015; Lifetime Homes, 2010). The explanation of AD part M and 16 design criteria are list as below.

AD Part M (Approved Document M, UK building regulation) provides guidance about building construction, including 1) Access to buildings, 2) Access into buildings, 3) Horizontal

and vertical circulation in buildings, 4) Facilities in buildings, and 5) Sanitary accommodation in buildings. Design criteria and provision examples are given through this guidance. Some of the examples of the design considerations and provisions from the guidance are listed in table 2.1.

Table 2.1 Access to and use of buildings (adapted from HM Government, 2015)

	Design consideration examples	Provisions examples
Access to buildings	Where the gradient of the approach, whether over its whole length or in part, is 1:20 or steeper, that part of the approach should be designed as ramped access.	The gradient along its length is either no steeper than 1:60 along its whole length, or less steep than 1:20 with level landings (see 1.26(k)) introduced for each 500mm rise of the access (where necessary, between landings), in all cases with a cross-fall gradient no steeper than 1:40
Access into buildings	A powered door opening and closing system, either manually controlled or automatically operated by sensors, is the most satisfactory solution for most people. An automatic sliding door arrangement is particularly beneficial as it avoids the risks associated with automatic swing doors and its use can make it possible to reduce the length of any entrance lobby.	Where required to be self-closing, a power-operated door opening and closing system is used when through calculation and experience it appears that it will not be possible otherwise for a person to open the door using a force not more than 30N at the leading edge from 0° (the door in the closed position) to 30° open, and not more than 22.5N at the leading edge from 30° to 60° of the opening cycle;
Horizontal and vertical circulation in buildings	An internal lobby should allow a wheelchair user, with or without a companion, or a person pushing a pram or buggy to move clear of one door before attempting to open the second door, as indicated in 2.27, under ‘External lobbies‘.	Their width (excluding any projections into the space) is at least 1200mm (or (DL1 or DL2) + 300mm) whichever is the greater when single leaf doors are used, and at least 1800mm when double leaf doors are used;
Facilities in buildings	The key factors that affect the use of switches, outlets and controls are ease of operation, visibility, height and freedom from obstruction.	Wall-mounted socket outlets, telephone points and TV sockets are located between 400mm and 1000mm above the floor, with a preference for the lower end of the range;

Sanitary accommodation in buildings	Wheelchair users and ambulant disabled people should be able to wash or bathe either independently or with assistance from others. The relationship of the bath to other sanitary fittings, and to the space required for manoeuvring, is therefore critical. Providing a choice of bathroom layout, wherever possible, will meet the needs of many disabled people and help maintain their independence.	The floor of a bathroom is slip resistant when dry or when wet; the bath is provided with a transfer seat, 400mm deep and equal to the width of the bath; doors are preferably outward opening and are fitted with a horizontal closing bar fixed to the inside face;

16 design criteria for Lifetime Homes is a technical guidance document, which is intended to make homes more easily adaptable for lifetime use at minimal cost for all generations, including disabled people. This guidance can be used for architects, planners, developers, builders and local authorities (Lifetime Homes, 2010) to develop new lifetime homes and communities. Table 2.2 shows some examples of the 16 design criteria.

Table 2.2 Lifetime Home 16 Design Criteria (adapted from Lifetime Homes, 2010)

	Practice recommendations (examples)
Criterion 1– Parking (width or widening capability)	Increase the width or widening capability of the parking from 3300mm to 3600mm. Provide all carports with a minimum clear width of 3300mm (3600mm preferred) regardless of whether or not they provide the only parking space for the dwelling.
Criterion 2 – Approach to dwelling from parking (distance, gradients and widths)	Increase the width of the path between the parking and the dwelling within individual dwelling curtilages to 1200mm, particularly if there is a change in direction.
Criterion 3 – Approach to all entrances	Increase the width of communal paths to 1800mm.

Criterion 4 – Entrances	Wider effective clear widths at communal doors (greater than the minimum required above) can be beneficial for the movement of furniture and personal effects of residents.
Criterion 5– Communal stairs and lifts	Provide lift access to all dwellings above entrance level as far as practicable.
Criterion 6 – Internal doorways and hallways	Subject to provision of adequate door opening widths (as detailed in the table below), the minimum width of any hallway/landing in a dwelling is 900mm. This may reduce to 750mm at 'pinch points' (e.g. beside a radiator) as long as the reduced width is not opposite, or adjacent to, a doorway.
Criterion 7 – Circulation Space	Kitchen layouts, whenever possible, should be planned so that they can include (following adaptation) a continuous run of units, unbroken by doorways, including: a built in oven at an accessible height beside a minimum 600mm of work surface, a hob beside a further minimum 600mm of work surface, and a sink/drainer. This continuous run, uninterrupted by doorways, (c. 3600mm in length measured along the front face) could be straight, L shaped, or U shaped. In addition, window positions should not impede on the oven or hob positions. Space for other typical 'white goods' and fittings should be available elsewhere in the kitchen (so that only the oven and hob are contained within this particular length of run).
Criterion 8 – Entrance level living space	Any permanent living room, living area, dining room, dining area (e.g. within a kitchen/diner), or other reception

	area that provides seating / socialising space for the household and visitors.
Criterion 9 – Potential for entrance level bed-space	A layout which provides potential for a suitable recess / area that is easier to screen and provides better separation from the remaining room is beneficial.
Criterion 10 – Entrance level WC and shower drainage	Position the WC and a hand rinse basin so that the basin can be reached from the WC position. Provide wall hung fittings to create greater manoeuvrability at floor level and ease of cleaning.
Criterion 11 - WC and bathroom walls	Adequate fixing and support for grab rails should be available at any location on all walls, within a height band of 300mm – 1800mm from the floor.
Criterion 12 – Stairs and potential through-floor lift in dwellings	Although stair lifts are available for installation on most forms of stair, a straight flight with clear landings at the top and bottom, will provide for a more cost-effective installation.
Criterion 13 – Potential for fitting of hoists and bedroom / bathroom relationship	Locate this bedroom and bathroom adjacent to each other with a connecting full height 'knock out panel' sufficient to form a direct doorway with a minimum clear opening width of 900mm between the two rooms, or have a direct (en-suite) link with a minimum clear doorway opening of 900mm from the outset.
Criterion 14 – Bathrooms	Where possible, the bathroom should also provide for a direct connection with a main bedroom. This will normally take the form of a full height knockout panel, capable of

	being fitted with a doorset, which achieves a clear opening in accordance with Criterion 6.
Criterion 15 – Glazing and window handle heights	To allow a reasonable view from the principal living space, the principal window in this living space, or glazed doors (where these are in lieu of the principle window) should include glazing that starts no higher than 800mm above floor level. In addition, any full width transom or sill within the field of vision (normally extending up to 1700mm above floor level) should be at least 400mm in height away from any other transom or balcony balustrade. All dimensional requirements within this paragraph are nominal (+/- 50mm acceptable). There should be potential for an approach route 750mm wide to enable a wheelchair user. To approach a window in each habitable room (see Note 1). In addition, this window should have handles/controls to an opening light no higher than 1200mm from the floor.
Criterion 16 – Location of service controls	Whenever possible, locate similar controls in consistent locations throughout the dwelling. Specify taps that are operable by people with less hand dexterity. Provide controls that give tonal contrast against their surroundings.

Despite these regulations, some researchers have criticised that the inclusive standards are not adequate for existing homes (Milner and Madigan, 2004). They argued that there was still a considerable gap in the provision of fully accessible homes for wheelchair users in their existing homes, as the majority of the '16 lifetime criteria of lifetime homes' focused on physical access of new homes. Consequently, the current design standards are mandatory for all new homes but have been rarely applied for the existing homes of older people. As discussed

in the previous section 1.1.3 (the older people's living situation in the UK), some older people have lived in their current homes for over 30 years, but the design of their homes does not match with the "'AD Part M' and '16 design criteria of lifetime homes' regulations. To help monitor existing homes, the UK government established a Health and Safety Rating System (HHSRS) to help property owners and related professionals recognise current home hazards (Department for Communities and Local Government, 2006), in order to protect older people's health and safety at home. To solve these existing home environment problems for older people, inclusive design is widely used in the design and social science fields.

2.4 Inclusive design

Inclusive design is a general approach for designing products, services and environments that are accessible to all, regardless of age, (dis)ability or other factors (Design council, 2006). It also called Design for All (in Europe) and Universal Design (in the USA). Clarkson and Coleman (2013) describe the history of inclusive design in the UK in the journal Applied Ergonomics. They describe the development of inclusive design in the UK from early beginnings, to the popular academic research topic it is nowadays. Inclusive design emerged in the mid 1990s and sought to link design and social needs. The term inclusive design was first used in 1994 by Coleman (Coleman, 1994) and focused on ageing and disability challenges and subsequent market opportunities. Then other designers and researchers adopted the term. The first time such an approach was taken in the UK could be traced back to 1963, when Goldsmith (Goldsmith, 1963) provided comprehensive guidance for wheelchair users accessing buildings. Then Goldsmith established the 967 BS Code of Practice CP96 on Access for the Disabled to Buildings and Part M of the UK Building Regulations. He also worked on designing products for supporting disabled children and adults in education, sports and other activities (Clarkson and Coleman, 2015).

Nowadays, inclusive design is applied in various sectors, such as housing, transport, healthcare, culture and leisure, education commercial, heritage, government, retail and neighbourhood (Design Council, 2020). In terms of the scope of this research project, the author focused on studying of the inclusive space design (also called inclusive environment design) and inclusive product design at home environment for older people, so that they can be easily and safely used by older people, no matter what gender, household type or disability (Inclusive Design Hub, 2018).

2.4.1 Inclusive space design

Inclusive space design in this research refers to the architectural structure and interior space design of older people's homes. In order to research the key elements of space design, various aspects of interior layout subject have been studied in the previous literature. The design council has explained the five key principles of inclusive design for new buildings, which are 1) inclusive design places people at the heart of the design process; 2) inclusive design acknowledges diversity and difference; 3) inclusive design offers choice where a single design solution cannot accommodate all users; 4) inclusive design provides for flexibility in use; and 5) inclusive design provides buildings and environments that are convenient and enjoyable to use for everyone (CABE, 2006).

To investigate the key elements of inclusive space design that may affect older people's living experience, literature has been reviewed using the terms of 'environment design' and 'interior design'. After finding the key elements of space design, the author moved on to search for particular areas (key elements of space design), such as floor and adaptations. Mohammad et al (2014) investigated a systematic review of interior layout design and developed parameters and sub-parameters for interior layout design that affected users' comfort in a building (see table 2.3). The space related inclusive design has been researched from the perspective of floor surface design and carpet design to protect older people from fall accidents (Pynoos et al., 1989; Clemson et al, 1996). Moreover, researchers have highlighted that accessible space is important to older people's safety. The need for accessible space includes a wide doorway, a clear floor and an accessible furniture arrangement (Demirkan and Olguntürk, 2014). Furthermore, inclusive space design also covers structural changes or adaptations (Mohammad et al, 2014), such as the installation of handrails on walls to support older people when standing or walking, a wider living room entrance door for wheelchair users, or more space for moving and doing activities.

Table 2.3 Adapt from 'building aspect of layout design' by Mohammad, et al (2014)

Parameters	Sub-parameter	e. g
Two-dimensional horizontal layout (-)	Floor and ceiling colour Finishing Material Quality Type of window opening system	- colour of interior surfaces - selection of material of interior surfaces

	Orientation of opening system Space size (width and length) Space geometric shape Spatial arrangement	- size, shape, and material of window and another opening - spatial and climatic orientation of window and another opening - 2D interior space namely length and width - Geometrical shape of space - Ceiling height
Two-dimensional vertical layout (|)	Colour Themes in the space- Wall colour/ floor colours Finishing Material Finishing Material Quality Type of openings Position of openings Spatial arrangement/Interior Ceiling Height	- selection the colour of interior surfaces - selection the texture finishing material texture - selection the material of interior surfaces - size, shape, material, and system of window and another opening - Spatial and climatic location of window and another opening - Dividing of space by vertical elements - ceiling height
Three-Dimensional layout (o)	Space Volume Space Form Circulation Corridor Configuration Balcony configuration Interrelation between spaces privacy Human Ergonomic Automatic control systems Temperature Lighting Level Heating Cooling Ventilation Air quality Noise Furniture arrangement	- 3D - geometrical form of space - movement within the spaces - spatial size and arrangement of corridor - spatial size and arrangement of balcony - mutual connectedness of space - privacy - equipment design, as for workplace, intended to max productivity by reducing operator fatigued and discomfort - management of IEQ factors considering of automatic controlling of window, blind, light switch

	fixture and equipment Aesthetic	- position and arrangement of movable equipment - include fixture and Mechanical & Electrical equipment - Creation of attractive view in space

Additionally, research also indicates that the inclusive space design can affect indoor atmosphere design, such as illumination, air quality and temperature (Kavanaugh, 1996; Harrington and Harington; 2000; Rowles et al, 2003; Andersson, 2011; Gitlin et al, 2001; Farage et al, 2012). Therefore, the position and arrangement of the windows and radiators at home are entirely important. For instance, due to visual impairment among the elderly, researchers highlight the level of illumination in the environment as an important factor that impacts on their physical and psychological well-being, including artificial lighting and daylight through windows (Evans, 2003; Demirkan and Olgutürk, 2014; Maguire et al, 2014; Tsunetsugu et al, 2005; Tian et al, 2014). Heating systems in older people's living rooms are also significant, especially as many older people prefer to stay in one room during cold months (the living room being the most likely room) in order to avoid costs associated with heating the whole house (NHS, 2014; Ledwith, 2013). Therefore, to ensure the home environment of the elderly is effective, comfortable, and safe, inclusive space design needs to consider illumination, air quality and temperature.

In addition, research indicates that some older people benefit from not only a functional inclusive space design but also an aesthetic experience that influences the emotions of daily activities (Andersson, 2011). For instance, Rechavi (2009) observed "aesthetic appeal in the living room, and it seemed as though this was intended, in part for their own pleasure, but also in an attempt to please and impress and please guests". According to Caspari (2004), the aesthetics of the environment may alleviate suffering, such as to dementia patient. Colourful materials on surfaces, such as a tablecloth, could reduce their sense of fear and give them more emotional bond. Therefore, any research into the inclusive design for older people at home should therefore consider functionality and aesthetics.

Although key elements of inclusive space design has been studied by various researchers, inclusive space design at home for older people has not been studied systematically, especially from the design perspective (as opposed to environmental gerontology perspective). Therefore,

research on how to improve inclusive space design for older people's home environments in the UK is still needed.

2.4.2 Inclusive product and furniture design for home environment

In this section, the author reviewed the literature and theories regarding inclusive product design, such as human-centred product design, ergonomics product design and age-friendly product design for the home environment. In order to provide an inclusive environment for older people at home, understanding the way products, furniture and assistive technology is used in the home is important. The UK Design Council give seven principles to follow for inclusive design, these are 1) Inclusive, so everyone can use them safely, easily and with dignity; 2) Responsive, taking account of what people say they need and want; 3) Flexible, so different people can use them in different ways; 4) Convenient, so everyone can use them without too much effort or separation; 5) Accommodating, for all people, regardless of their age, gender, mobility, ethnicity or circumstances; 6) Welcoming, with no disabling barriers that might exclude some people; 7) Realistic, offering more than one solution to help balance everyone's needs and recognising that one solution may not work for all.(CABE, 2006).

Inclusive products design at home

Inclusive products, such as age-friendly and ergonomic product design has been widely researched by designers and engineers in recent decades. Some assistive products are designed to be attached to a home structure, others can be directly applied by a person using an item at home to support and enhance the everyday competencies of individuals (Wahl et al. 2009). For instance, Finkel et al (1997) developed guidelines for the design of a four-wheeled walker used in the living room to improve or solve mobility and balance problems that older people face. Though the four-wheeled walker has a good design improvement, Riel et al., (2014) presented evidence that older adults can still fall while using a four-wheeled walker and suffer severe injuries as a consequence. Maki et al (2008) proposed interventions of mobility aids and handrail cueing systems to reduce fall risks for older people at home. Furthermore, Fernite (1992) reported on a vertical pole lamp named SturdyGrip™ to support prolonged standing or physical stability for older people, acting in the same way as grab bars and handrails at home. Adjustable chairs can help to reduce prolonged stress on the neck and back when older people have a habit of sitting for long periods (Pinto et al, 2000). Adjustable beds were designed to

change the position and height level of a mattress to relieve pressure and prevent muscle contractions. Moreover, some simple monitoring devices designed to facilitate communication between older people and their caregivers, such as intercoms (Milligan et al, 2011) have been used for maintaining older people living independent at home.

In addition, Assistive Technologies (AT), such as devices that can be attached to a home structure, have been applied to improve the independent mobility of older people, such as a wheelchair (Roone et al, 2015), walking aids (Maguire, 2012), cane (Wade et al, 2015) and reacher (Mcnay, 2015). However, Clarkson and Coleman (2015) argued that many new products are too complex in their design and hence lose their inclusivity. As older people are less likely to use new technology compared to younger generations, debates related to accessibility of technology for older people is still a controversial topic.

Whilst much attention has been paid in recent years to the usefulness (usability) of new products and technologies in facilitating independence within the home, there lacks a holistic approach to home environment design (Renaut et al, 2015). Although results from existing home product design research are notable, most of these studies mainly focus on functionality and usability. Few of them have systematically considered possible environments, and the circumstances that end users (older people) may use or operate the products. For example, older people might not be able to use installed handrails and walking aids due to a narrow hallway at home or discomfort with new technologies (National Research Council, 2011). Thus, it is essential to explore not only home-related products, but more importantly, to understand interactions between the products and the implications of their use in a home environment.

Environment aesthetics

In order to create an inclusive environment, aesthetics should also be taken into consideration. Additional decorative items are another important element in older people's living rooms. Decorative items have a positive influence on mental health, bringing pleasure, peace and harmony to the home (Rechavi, 2009; Hauge and Kristin, 2008). These items include photographs, paintings, mirrors, books, knick-knacks etc, which are psychologically important to older people and have sentimental value.

Additional decoration also shows in the colour theme of furniture. Not only is the function of the furniture and product essential to older people at home, the colour usage of the furniture and product is important as well. The colour of furniture or products in the living room is as

important as the colour used in space design. Visual accessibility can be improved by the clever use of colour on furniture or objects (Brawley, 2008; Harrington and Harrington, 2000), high contrast handles on furniture, or colour-coded instruction labels on technology facilities. Brawley (2008) also emphasised the importance of material and fabric, which delight the eyes and hands and inspire comfort and safety. Sharp edges and corners of furniture also pose risks to people with decreasing visual acuity (CEN/CENELEC Guide 6, 2014). Older people find it harder to distinguish between objects and background, especially for those who have cataracts, macular degeneration, glaucoma and diabetic eye diseases (Sinclair, Ryan and Hill, 2014). Wood et al (2011) highlighted the relationship between contrast sensitivity in the environment and falls or other injuries among older people's daily activities. The findings show that low contrast surface transitions such as on stairs and for other objects (such as kerbs) are harder for older people to distinguish (Wood et al, 2011). In addition, Nolan (2002) explored the impact of glare on space perception and found that light reflecting on shiny furniture surfaces and glossy floors may be problematic for older people (Nolan, 2008). Light weakness at home can cause health risks, such as older people's pupils becoming smaller and less able to allow light to enter the eye (Pirkl, 1994; Weale, 1961). Older people need more illumination in order to see sharply (Farage et al, 2012). Tian et al (2014) explore how illumination affects older people when they step over obstacles and emphasise that poor illumination can cause falls. Older people discriminate bright, warm colours more easily than cool ones (Wijk et al., 1999).

Furniture arrangement

How to arrange furniture products within the home inclusive environment needs to be studied. Furniture arrangement and layout can affect the accessibility and usability of furniture (Merrell et al, 2011; Evans, 2003; Yu et al, 2011; Saruwono et al, 2012). For instance, in order to have a comfortable distance between people, older people may need to move chairs in the living room during home activity (Evans, 2003). Additionally, furniture should be placed in an open space so cupboards (i.e. around the room) can be opened easily (Mohammad et al, 2014). Researchers also indicated that to develop an easy-access furniture layout, one needs to understand the relationship between furniture and how people *use* the furniture in a home environment. It is not enough just to design furniture pieces in isolation. Gitlin (2003) developed an "everyday adaptive responses" approach to measure experience at home, so as to improve home assistive products or home modification of designs. The approach refers to the

subjective experiences resulting from older people's interaction with products when they accomplish their daily routines and self-care activities.

The majority of research studies focus on how to layout the furniture in the living room in order to gain the most functional usage. For example, figure 2.1 shows the study from Merrell et al (2011) on different ways to layout the living room furniture. This led to a set of interior design guidelines. However, there is a lack of studies on furniture layout design for older people at home, especially for those single household older people. How to use the space more efficiently needs further consideration.

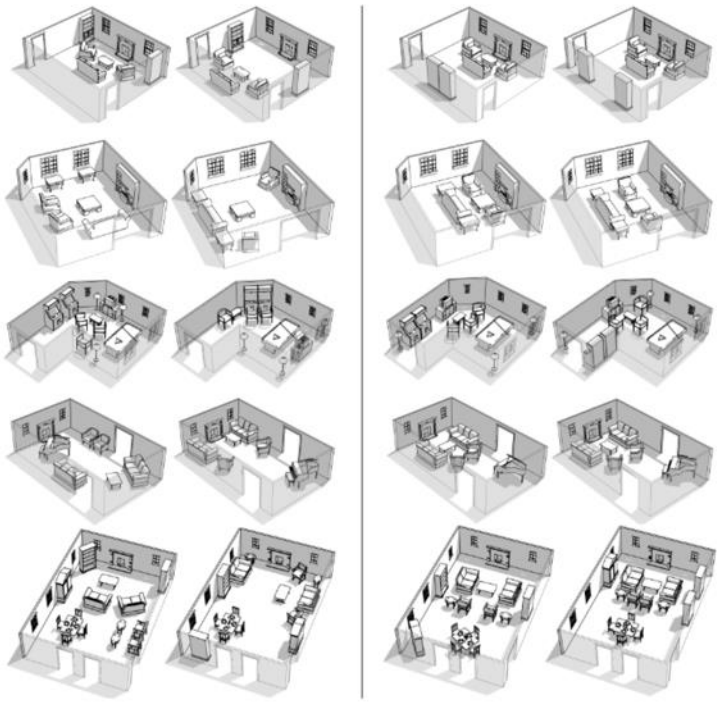

Figure 2.1 Interactive furniture layout using interior design guidelines (Merrell et al, 2011)

2.5 Interaction between space, product and people

As products express multi-functions when they interact with the home environment and older people in different circumstances, it is important to explore how the products can fit dynamic lifestyles and personalised home environments (Jonsson, 2013, p21). Pallasmaa (1994) highlighted *"*The approaching of the house, not the facade; the act of entering, not the door; the act of looking out of the window, not the window itself; or the act of gathering around rather than the hearth or the table as such seem to trigger our strongest emotions*"*. Lord, Menz

and Sherrington (2006) indicated that it is also important to investigate the interactions between older people's physical abilities and their home environment. Marquardt et al (2011) investigated the relationship between home architectural space (space layout) and activities of daily living among older people with dementia. Their study has confirmed that a well-planned layout can help older people perform their daily activities with enhanced confidence and aid memory related tasks (Marquardt et al, 2011).

Additionally, some research has developed interdisciplinary methods that cover design, gerontology, engineering and medical science theories to improve inclusive home design for older people (Baskinger, 2007; Peace et al, 2001). For example, Dewsbury et al (2003) explored possibilities of smart home applications such as auto-adjust lighting, security systems and weather sensitive curtains. Baskinger (2007) developed approaches to empower visually impaired people by embedding an assistive coloured interface design for home applications (such as washing machines or microwave ovens). Nawaz et al (2014) designed a smart home system with a touch screen interface to prevent falls and aid recovery when falls do occur. It is important to understand the 'lived experience' at home from multiple perspectives, looking at product adaptability, functionality and usability. This leads to a greater understanding of how layout and assistive technology can increase the sense of autonomy among the older generation, enhancing both their well-being and safety. A holistic perspective therefore covers interactivity, preventative measures, comfort and security – and the living room, as the epicentre of many elderly people's lives, is vital to their home living experience.

The theory of Person-Environment (P-E) fit, suggested by Kahana (1982), was used by studies that examine the relationship between environment and older people's health and well-being (Sánchez-González and Rodríguez-Rodríguez, 2016; Seo and Fiore, 2016; Park et al, 2015; Oswald et al, 2007). Verbrugge and Jette (1994) underscored "the disablement process", as an important reference in the field of P-E fit and ageing studies (Gitlin, 2003; Satariano, 2005; Seidel et al, 2010; Seo and Fiore, 2016). This process argued that environmental conditions should correlate with older people's capabilities (e.g., level of competence) and requirements (e.g. applying adaptations objects). Subsequently, many design-for-ageing related studies highlight the concept of ergonomics, giving specific attention to exploring how the experience of aging 'in place' might differ between different groups of older people (Harrington and Harrington, 2000; Pinto et al, 1997; Yu et al, 2011; Wills et al, 2013). For instance, Pinto et al

(2000) explored the use of entrance and kitchen environment at home, analysing living behaviour and observing collision issues among older people with furniture.

Moreover, to investigate older people's living room experience, the age-related change factors need to be considered. It has been mentioned of the age-related change for older people in section 2.2, that this includes physical change (in eyes, ears, hand, body mobility, etc.) and psychological changes (desire for independence, sense of personal control and autonomy, etc.). Therefore, to develop design insights for older people's experience in the home living room, correlations between space, objects and person must be considered.

Why the living room?

As older people spend most of their time at home, home is an important place for them in their later life (Pinto et al, 2000). Older people need a comfortable home environment for living. In the environmental and ageing research field, in order to improve home design, many studies examined the relationship between home environment and the well-being of elders from both physical and psychological perspectives (Iwarsson et al, 2007; Weich et al, 2002). For example, to investigate the association between living environment and mental health, Marquardt et al (2011) explored relationships between living environment and older people's mental health and discussed how space layout design can help people with dementia to live independently. They confirmed that a legible and functional space design improved cognitive skills for people with dementia.

Older people also need a home environment convenient for their relatives, friends, and neighbours to visit easily (Pirker and Bernhaupt, 2011). Yet mainstream houses in the UK are unsuitable for the elderly as most were not designed with sufficient accessibility in mind (Severinsen et al, 2016). For example, the house might be inconvenient because of multiple floors, not accommodating older people's lifestyles, having an inflexible and impractical furniture arrangement, a high maintenance fee, or be in an inconvenient location (Kelly, 2001).

Homes are unique. In the home environment research field, homes vary widely in location, size, condition, and physical characteristics (Wahl et al., 2009). The physical environment of the home is dynamic, personal, diverse and uncontrolled by outside forces (Gitlin, 2003). To meet older people's needs, existing home environment guidelines mainly focus on the environment factors (AgeUK, 2015; Habinteg, 2015) but do not account for personal factors (such as physical ability). Additionally, general guidelines and solutions may be suitable for

one household but may not be appropriate or effective for others. Consequently, holistic guidelines that consider household composition or individual behaviour for specific home environments (house, flat or bungalow) are indispensable to develop.

Living room activities

To have a comprehensive understanding of the living room experience for older people, activities (such as individual activities, e.g. reading, or activities with friends, e.g. entertainment) in the living room need consideration. It is necessary to know what kind of activities are held in the living room of older people and highlight the need for multi-functional living rooms to allow older people to do activities by themselves, with other household members (husband/wife), or with friends/families from outside the household.

Based on previous literature, the purpose of using the living room could be divided into three aspects, a) doing activities alone b) doing activities with household members, and c) doing activities with people from outside of the household. Rechavi (2009) has investigated studies focusing on how people use their living room while alone. The findings show that this room is frequently used as a space of solitude – it is a private space, especially where space is restricted. Saruwono et al (2012) highlighted the living room as a place of reading, journal writing, and even meditation, "to watch the television, exercise, or even simply watch the view outside their windows". It can be "a place of contemplation: thoughts about one's life". Here one can also spend time with other household members, or partners (Rechavi, 2009; Saruwono et al, 2012). For example, these activities include playing board games (Pirker and Bernhaupt, 2011), discussing special issues, having dinners and watching television. Thirdly, the living room acts as an interface between the private and the public worlds. It is a space where contact with the outside world may be initiated (Woodward, 2001), and is a main area to receive and entertain guests (Saruwono et al, 2012).

2.6 Conceptual framework

From the literature review, the research explored the important factors for home environment and space design and how these factors influence the interactions of the elderly with their space/environment, products and other people. This was used to establish a conceptual framework to represent their interactions between space, products and people in a living space at home.

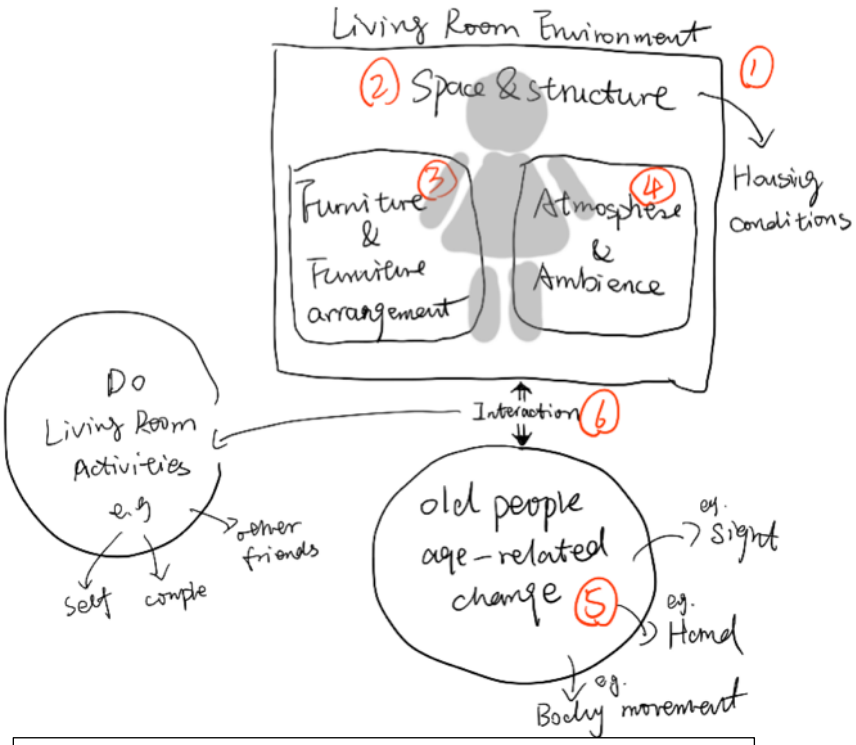

Figure 2.2: Sketch of research scope (By the author, 2020)

The environment for home-based design is multi-layered, affecting daily activities and healthcare for older people (National Research Council, 2011). Researchers have developed different categorizations of the home environment elements that nevertheless encompass similar variables, such as furniture layout design, wall colour, and lighting (National Research Council, 2011; Evans, 2003; Demirkan and Olguntürk, 2014; Mohammad et al, 2014). These elements can be used more specifically for the living room environment in this research. Through the literature review, key elements have been collected and discussed regarding the influences of older people's experience in their living room in chapter two. Based on the identified key elements, a conceptual framework for living room environment design for older people (figure 2.3) has been developed from the research scope shown in Figure 2.2. It presents the key elements in the six main categories that were mentioned in chapter one and chapter two: 1) living environment (e.g., house type, house age), 2) living room space and structure (unmoveable elements in the living room, e.g. wall, floor, structure, etc), 3) furniture and furniture arrangement (movable objects in the living room), 4) atmosphere (elements that influence living room atmosphere design, e.g., feeling of light, air quality and temperature in the living room), 5) age-related changes, and 6) how these previous 5 elements interact with

older people. The following subsections will review these elements and figure out the key points for each element.

Combining all of the six elements mentioned above, the conceptual framework for the literature review has been confirmed (Figure 2.3). The next section will show the research gap and confirm the research aim and objectives.

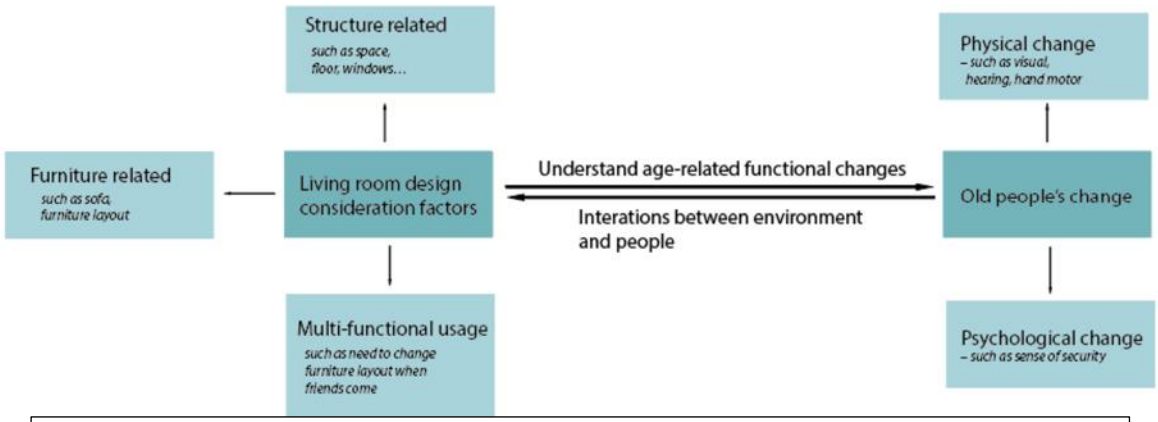

Figure 2.3 Conceptual framework in this research from literature review (by the author, 2020)

2.7 Research Gap Aim and Objectives

Though the living room is essential to older people, lack of study in this area means research gaps still remain.

1) Many studies on home environment design focused on how to develop new houses or new retirement villages for older people in the UK (GOV. UK, 2015). But many older people cannot afford these and still need to stay in their current home. Few studies have discussed how to improve the current living environment to provide sufficient living and caring support for older people that allow them to stay in their original home as long as they want.
2) Moreover, numerous studies in inclusive design research concentrated on the function room of kitchen and bathroom, such as ergonomic kitchen design for older people (Maguire et al, 2014) and user-friendly bathroom design for older people (Chuah et al., 2016; Chamberlain et al., 2011; Quitzau and Røpke, 2009; Gitlin et al, 1999). Furthermore, current research also concentrated on product design for older people at

home, such as assistive lighting for people with sight loss (Fisk and Raynham, 2014), and preventing falls by home-based technologies combined with a monitoring assistive centre (Tchalla et al, 2012). There is a paucity of research that has explored older peoples' living room design at home and the interactions with the living room spaces, products in the living room and people in the living room.

3) From an ergonomics design aspect, a great deal of research focused on the functionality and usability of home modification and adaptive devices. However, relationships between product and environment were neglected from most of these studies, especially how the products have been used under different activities and circumstances in a living room in an older person's home.
4) Moreover, the existing home environment design has focused more on other countries, such as New Zealand, The Netherlands and Denmark. Furthermore, the ageing situation was researched many years ago, but the living habits and behaviour of older people in the UK have changed in recent decades. Therefore, the living room environment design for older people in the UK cultural context requires new research.
5) Many researchers have highlighted health and safety risks and barriers in the home environment associated with older people (Gitlin et al, 2001; Lord et al, 2006; Fänge and Iwarsson, 2003; Iwarsson, 2004; Iwarsson, 2005; Stark, 2004; Wahl et al., 1999). In response to this, in recent years numerous housing planners, commissioners and designers have considered the special needs of older people with physical and mental health issues and focused on inclusive design for improving the home environment for an ageing society (CABE, 2009; Williams, 1990). Also, the EHS study suggests that the majority of older people's homes still have risks as they have limited inclusive design features due to lack of knowledge, monetary or time constraints. Therefore, in terms of the application of inclusive design in older people's current homes there is still a long way to go. It needs the researchers, designers, housing planners, commissioners, and other stakeholders to work together to develop and promote low cost and ageing friendly home design for older people.

After searching and studying the previous literature, the author found that many studies on home environment design focused on how to develop new houses or new retirement villages for older people in the UK (GOV. UK, 2015). Few studies have discussed how to improve the current living environment to provide sufficient living and caring support for older people that enables them to stay in their original home as long as they want. Moreover, numerous studies

in inclusive environment design research concentrate on ergonomic kitchen design (Maguire et al, 2014), bathroom design (Chuah et al., 2016; Chamberlain et al., 2011; Quitzau and Røpke, 2009; Gitlin et al, 1999), assistive lighting for people with sight loss (Fisk and Raynham, 2014), and preventing falls by home-based technologies combined with a monitoring assistive service centre (Tchalla et al, 2012) for older people at home. There is a paucity of research that has explored older peoples' interactions with spaces, furniture and people in the living room at home. From an ergonomics study aspect, a great deal of research focused on the functionality and usability of home modification and adaptive devices, and how people interact with the product itself. However, relationships between furniture and environment were neglected from most of these studies, especially how the products have been used under different activities and circumstances in a living room in older people's homes.

Due to aforementioned research gaps and with the intention of improving elderly living room experience, the aim of this research is to investigate the experiences of older people with their living room at home so as to identify risks and challenges they face in their day-to-day life and develop design insights for improving living room space design, furniture and furniture arrangement, and atmospheres design so as to improve older people's living room experience in the UK. In order to achieve the research aim, four objectives and two research questions are considered:

1) Study the home living situation and conditions of older people in the UK through the English Hosing Survey 2012.

2) Investigate older people's living experience with their living room at home in the UK.

3) Identify the challenges and needs that older people face in their living room at home under different scenarios and analyse the reasons behind these challenges.

4) Develop design insights and recommendations for improving living room environment design for older people in the UK.

Research questions:

1. How do older people currently use their living rooms for different activities and purposes?

2. To what extent do older people experience challenges and hazards in their living rooms?
3. How can we improve the living room environment for older people in the UK through better inclusive design?

Chapter 3 Methodology

3.1 Introduction

The previous chapter outlined the research scope and presented a literature review conceptual framework for older people's age-related change and design factors in the living room environment. Although existing studies have contributed to improving older people's health and wellbeing in multiple ways, very few studies explore older peoples' experience with their living room, especially from a design perspective. The living room has been identified as an important space for older people at home where they normally engage with multiple daily activities. A good understanding of how older people use their living room in terms of their interactions with objects in the living room and impact of living room layout and atmosphere on their daily behaviour can contribute to identifying potential risks and challenges people face at home and then bring insights for designers and other key stakeholders to improve living room design for this growing demographic group. Thus, this research attempts to explore elderly people's experience with the living room during day-to-day activities, and, in turn, to develop design insights to improve living room space and structure design, furniture and furniture arrangement, and atmosphere, so as to improve older people's living room experience in the UK. Chapter 3 presents the methodological approach that has been adopted in this research.

The structure of this chapter includes: a discussion of the qualitative and quantitative research methodologies and methods in section 3.2; an analysis of ethnographic research methods and an explanation of the content and procedure of the ethnographic user study in section 3.3; a sampling strategy and an introduction to the confirmed participant characteristics of the research in section 3.4; a introduction of research ethics in section 3.5; a introduction of the analytical approach and the analytical process of this research in section 3.6; a pilot study and feedback in section 3.7; and a conclusion in section 3.8.

3.2 Methodology

According to Myers (1997), a methodological strategy comprises research design and data collection. It is important to select appropriate research methods to help the research process collect reliable data and obtain valid results (Robson and McCartan, 2016; Easterby-Smith et al, 2012; Burns, 2000). In this section, fundamental methodological theories are discussed to

build up a suitable research strategy for investigating older people's current living situation and to observe their experiences with the living room at home. Research methodologies can generally be divided into two categories, qualitative and quantitative.

3.2.1 Qualitative methodology

Qualitative research is characterized by involving small samples of participants who can represent a group of the population, usually emphasising words through human-centred discoveries that lead to a deeper meaning, rather than broad collection of quantitative data from a large number of participants for statistical analysis (Bryman, 2015; Keegan, 2009; Denzin and Lincoln, 1994). Qualitative methods have been extensively used to investigate human subjectivities and understand human experiences through the perception of the participants (Burns, 2000; Robson and Foster, 1989). More specifically, the complexity of an individual's own world view can be observed through their words and behaviours, subsequently, researchers can obtain a deeper understanding of the participants' world from their perspectives (Creswell, 2013). Furthermore, researchers have confirmed that qualitative research is an essential approach to observe possible interaction relationships and the natural behaviour of participants in a certain environment (Brannen, 1992; Quesenbery and Brooks, 2010). These methods can help the author to deeply understand older peoples' perceptions of their living room design and observe their experience and interactions with living room furniture, layout design, atmosphere and multiple activities. More frequently used qualitative data collection methods include interviews, observations, ethnography and focus groups (Creswell and Poth, 2017). Data resources include documents, texts, audio, videos, pictures, and researcher's impressions (Myers, 2013). Many researchers analyse qualitative data via software tools, such as Nvivo, for coding, analysis and tracking the data (Recker, 2012).

3.2.2 Quantitative methodology

Quantitative methods, conversely, are characterized by involving a large sample of participants with data usually collected by questionnaires and surveys (Keegan, 2009). It is a research strategy to make use of numerical data for generalizing to a particular phenomenon (Keegan, 2009; Bryman, 2015; Creswell, 2013). The advantages of quantitative approach include having easily controlled variables by question design, and receiving precision results by reliable measurement (Tashakkori, 1998). It is used for statistical analysis of relationships between two things, such as comparisons or correlations of two variables, which can test causations and to

confirm an assumption (Newman and Benz, 1998; Brannen, 1992; Morse, 1991). In addition, quantitative methods are identified as an objective approach, which normally has a large sample and strong evidence to mitigate against a researcher's sense of personal intuition and bias (Sale et al., 2002). Thus, a quantitative method can help the author to have a big picture view of older people's current living situation and the issues they face at home in the UK, and to develop sampling strategies to select older people who face more risks and challenges than the general older population in their living room for this study. Quantitative data can be collected through questionnaire survey and interview survey or accessed via established research databases. The most popular techniques for analysing quantitative data are descriptive analysis and inferential analysis (Bhattacherjee, 2012) via software tools such as SPSS.

3.2.3 Mixed methodology

Table 3.1 Comparison of qualitative and quantitative methodology (Castellan, 2010)

Components of Research Approaches	Quantitative	Qualitative
Philosophical Assumptions	Positivist perspective, objective reality, researcher is independent of that which is researched	Postpositivist perspective, naturalistic, social, multiple & subjective reality where researcher interacts with that being researched
Method/Types of Research	Experimental, quasi-experimental, single subject and descriptive, comparative, correlational, ex post facto	Phenomenology, case study, ethnography, grounded theory, cultural studies
Purpose/Goal of Research	Generalizability, explanation, prediction	Understanding, insight, contextualization and interpretation
Questions or Hypothesis	Hypothesis is informed guess or prediction	Question is evolving, general and flexible
Those Being Researched	Randomly selected sample, proportionally representative of population	Usually a small number of non-representative cases
Those Conducting the Research	Etic (outsider's point of view); objective, neutral , detached and impartial	Emic (insider's point of view);personal involvement and partiality
Data	Questionnaires, surveys, tests, etc. in the form of numbers and statistics	Written documents from field work, interviews, pictures, observations, objects, etc.
Data Analysis	Deductive process, statistical procedures	Inductive process: codes, themes, patterns to theory

Through discussing the nature and purposes of qualitative and quantitative methodologies, it is consequently summarized that a qualitative approach is used to achieve in-depth understanding of a particular phenomenon, while a quantitative approach is used to achieve a broad scope

understanding of a particular situation (Patton, 2002; Silverman, 2013). Table 3.1 summarizes more details of the differences between qualitative and quantitative approaches (Castellan, 2010).

Although both qualitative and quantitative methods are very useful, they do have limitations. In terms of qualitative methods, sample size and the time-consuming nature of the process are the main limitations. Due to limited resources and time in a qualitative study, it cannot involve a large number of participants (Recker, 2013). In terms of quantitative approach, although it can help the researcher to discover a big picture of a scenario, it cannot obtain details and reasons behind an analysis. Additionally, it normally engenders huge costs to collect a large dataset (Recker, 2013).

As a response to the criticisms faced by qualitative or quantitative inquiry, there is a tendency for many researchers to explicitly integrate both approaches in order to overcome the limitations from each side; this is called mixed methods. It allows researchers to understand a phenomenon deeply and widely (Recker, 2013; Creswell and Clark, 2007; Palinkas et al., 2011). Therefore, in order to achieve the research aim more reliably, this research employs a mix-method strategy.

Justifications for using mixed method have been widely discussed in the academic areas. A mixed method is a triangular and complementary approach that can explore and confirm the same problem by using different resources and different methods to develop a clear picture and new ideas (Kaplan and Duchon, 1988; Johnson and Onwuegbuzie, 2004). The scope of research can be developed or expanded through one research method to another one (Johnson and Onwuegbuzie, 2004).

3.2.4 An ethnographic method for this project

The author developed an ethnographic qualitative method to establish an in-depth understanding of the kinds of challenges and needs that the target users (older people) face, and reasons behind those issues. Figure 3.1 displays how a qualitative method has been applied to achieve the research objectives and relationships between each objective in this research. The research triangulation strategy and how to evaluate the data collection will explain in section 3.4. The next section will present details of research design that includes research methods selection, participant engagement process, data analysis and research ethics.

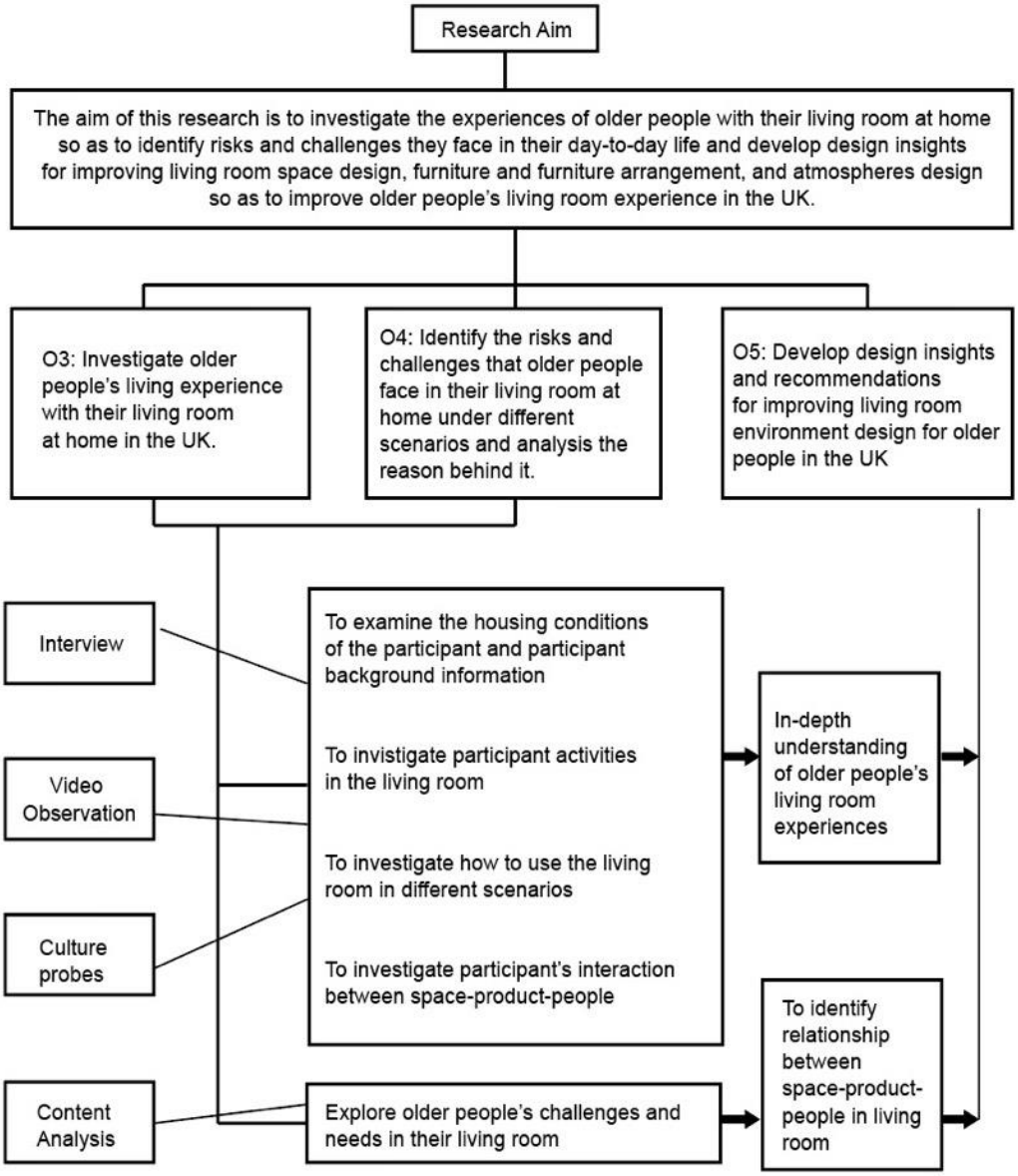

Figure 3.1 Framework of qualitative approaches used in this research (by the author, 2020)

3.3 Ethnographic user study research design

Research objective 3 intends to investigate older people's living experience in the living room at home. This research will use an ethnographic approach to achieve this aim. The reason for the selection of an ethnographic user study is that this approach has great advantages to explore people's experience, behaviour, and demands, over a period of time, and provides rich and detailed data for researchers (Christine, 2010). Therefore, via using this method, the author can have a deep understanding of how people interact with space and furniture in their living room and the impact of this on their behaviour and experience. Moreover, the ethnographic method is identified as an appropriate approach in interior environmental design and ageing studies because it can obtain rich information from participants that allows the author to understand older people's living habits and behaviour from their day-to-day activities. (Pattison and Stedmon, 2006; Wortham, 2010; Wills et al, 2013). In addition, the ethnographic approach is regarded as the science of user study to collect dynamic descriptive data from older people (Burns, 2000). Therefore, it allows the author to collect interpretive and descriptive data from participants. Therefore, the author finally selected this approach and designed a 9-week ethnographic user study. In this thesis, the ethnographic method refers to the user study method and relies on three different techniques including cultural probes, video-based observation, and in-depth interview. The next section will explain why this was chosen and how each technique was designed.

3.3.1 Cultural probe method

Cultural probe is an effective method to understand people's needs, environment elements and product usage in this research (Gaffney, 2006; Howard et al., 2006). It allows researchers to collect diverse materials from participants' perspectives with abundant information to eliminate subjective impressions (Fitton et al., 2004). Thus, cultural probes can support the author to discover elderly peoples' unmet needs and challenges in the living room environment from a participant viewpoint. The tools/materials of cultural probe data collection can be various based on the research purpose, such as text description (such as containing open-ended series of postcards or diary cards), camera, and maps (Bødker et al., 2003). For instance, Blyth et al (2002) successfully used the cultural probe method and designed "three wishes" postcards to guide their participants to write about their thinking for future technology development. In this research, the author designs a cultural probe packet that includes experience cards, diary cards, camera and voice recording devices to collect information from participants perspective

on their experience of their living room. Therefore, implementation of experience cards and diary cards helped the researcher to grab information of various kinds from the superficial physical setting to a deeper emotional insight regarding specific human interactions (Gaver et al, 2004; Mattelmäki et al, 2002).

3.3.1.1 Introducing the experience cards and diary cards

Table 3.2 information factors in living room environment (developed by the author)

*the terms of Living room layout design, Furniture Arrangement, and Living room atmosphere are changed to living room space and structure, furniture and furniture arrangement, and atmosphere after data analysis for a more suitable description. But on the experience cards, it used the previous term. Context are the same.

Context component	Classification	Examples
Living room layout design (space & structure)	Settled setting in living room	Wall, floor, window, celling light
Furniture Arrangement (furniture and furniture arrangement)	Movable environment design elements	Furniture, specific-designed furniture designed for ageing, technology products, decoration items, lamb or stand light
Living room Ambience (atmosphere)	Intangible environment factors	Natural light, artificial light, ventilation, temperature, sounds

This method was used to obtain open-ended and unbiased results from participants over an extended period of nine weeks (Creswell and Poth, 2017). The experience cards are designed to explore the impact of living room environment design such as space, furniture and atmosphere factors on older people's daily activities. The key factors of the living room environment that may affect people's behaviour and experience have already be discussed in Chapter 2 (Literature Review) and summarised in Table 3.2. The experience cards are designed with open-ended questions to encourage the participants to evaluate their living room environment design from aspects of living room layout design (space design), furniture arrangement (furniture and furniture arrangement) and atmosphere. In addition, for a better understanding of older people's daily activities, the author designed diary cards by using a 5W1H user scenario model, which was developed by Ha et al (2006) (Figure 3.2), More specifically, the model was applied with a 5W1H user scenario model that was developed by Ha et al (2006) (Figure 3.2) so as to build up a clear activity background for understanding

Figure 3.2 Relations of user behaviour context information factors in home environment (Ha et al, 2006)

what activities older people do during the day and how long they stay at home in the living room.

3.3.1.2 Implementation of experience cards and diary cards

Experience cards were provided to the participants between week one and week nine to capture the experience participants had in their living rooms. This also captured the interaction and experience respondents had with the space, furniture, space, light, windows in the living room. Diary cards were provided to the participants between week one and week nine to capture their general daily activities. This also captured participants' lifestyle, social interactions, and behaviours. The data from experience cards and diary cards were then analysed to study their collective and individual experiences. Each week, participants were asked to fill in four experience cards and three diary cards. Meanwhile, each week included an introduction page (Appendix 1, Appendix 2, Appendix 3) to guide participants on how to fill out the cards.

"Welcome to the First Week (round 1) of the living room experience user-study. In the envelope, you will find THREE double-sided Diary Cards and FOUR double-sided Experience Cards. We would like you to record your daily routines and habits for any three days during this week on the Diary Cards part one. And to summarise your living room activities on the Diary Cards part two. The areas of your living room that we would like you to focus on this week are **"Space/ Wall/ Floor/ Windows/ Lightings/ Switches/ Sockets".** For detailed instructions, please see the instruction booklet and don't hesitate to contact me if you have any questions.

----- Example of cover page of week 1

3.3.1.3 Content of experience cards

The key factors of the living room environment that may affect people's behaviour and experience have already been discussed in Chapter 2, Literature Review. Combined with table 3.2, key factors have been divided into three sections, which are:

- Space/Wall/Floor/Windows/Lightings/Switches/Sockets … (non-movable elements)
- Furniture/ Furniture Arrangement/Home Appliances/ Special designed products/ Decorative items … (movable elements)
- Natural light/ Ventilation/ Sounds/ Temperature… (invisible elements)

In order to guide participants to write the correct content, each section was designed with four cards and with open-ended questions to encourage the participants to evaluate their living room environment. The week one experience cards are attached in Appendix 4. For example, in week one, participants are asked questions 1) What do I have? 2) What do I care about? 3) When someone comes..., and 4) My wishes ... (Figure 3.4) For each question, there is paragraph to guide the participant to give the right answer, questions for week one are listed below:

Content on Card one:

Week 1 Experience cards 1/4 --- What do I have?

Depending on your existing living room environment, what do you think of the fixed design elements that are mentioned above? How have these elements affected your daily activities? You could share your good or bad experience with us and tell us the reasons behind it.

Content on Card two:

Week 1 Experience cards 2/4 --- What do I care?

Among the above listed fix-designed elements of a living room, which elements do you think are important to you or to other ageing generation? Why?

Content on Card three:

Week 1 Experience cards 3/4 When someone comes...

Please keep focusing on the fix-designed elements in your living room that mentioned above. And share your experience with us about how do you entertain/ host your families/friends/or guests in your living room. Are they affecting you to entertain/host them? What makes you happy? And why?

What challenges you or makes you feel inconvenienced? And why?

Content on Card four:

Week 1 Experience cards 4/4 My wishes ...

What is your dream living room?

Please select at least two elements from above that you might want to improve now or in the future. And tell us why you want to do so.

The author also encouraged the participants to write new elements on each card, in order to gain new concern points for the living room environment design from the participants' point of view. This was shown on the card as:

If you want to improve any other fix-designed items in your living room that not mentioned on this card, please write it down directly.

As the participants might not have rich knowledge of the living environment design, the author designed a "hints point" on the back of each of the cards to encourage and inspire participants to write appropriate information. The content of the hints followed the content of the cards. Such as the content on Week 1:

Space/Wall/Floor/Windows/Lightings/Switches/Sockets, Card one: What do I have?:

For example:

I am very pleased that all my sockets are re-fixed at a waist height on the wall two years ago. I don't need to bend my body down to reach it. That lets me feel comfortable.

Key points you may consider:

- Space accessibility/availability (such as pathway from kitchen to sofa);

- Wall material and colour;

- Floor material and colour;

- Window size and height; Window accessibility/functionality;

- Accessibility of switches and sockets;

- Accessibility/Usability of lightings...

In total, participants were asked to complete experience cards within the nine-week user study (Figure 3.3). For each week, they were asked to finish one section. As the author designed three different sections of content, every three-week counted as one round, so in total there were three rounds during the nine-week user study. Therefore, each card was repeated three times for each participant. The reason to design these three rounds were: 1) Avoid participant giving inaccurate feedback. At a subsequent visit, the author could check the content on the first-round cards and correct any issues; 2) The participants knew they were allowed to write repetitive information on same cards in the different rounds. We could then check what information is most important to them (repeat content); 3) The author could track how their idea/thoughts develop in a different timeline.

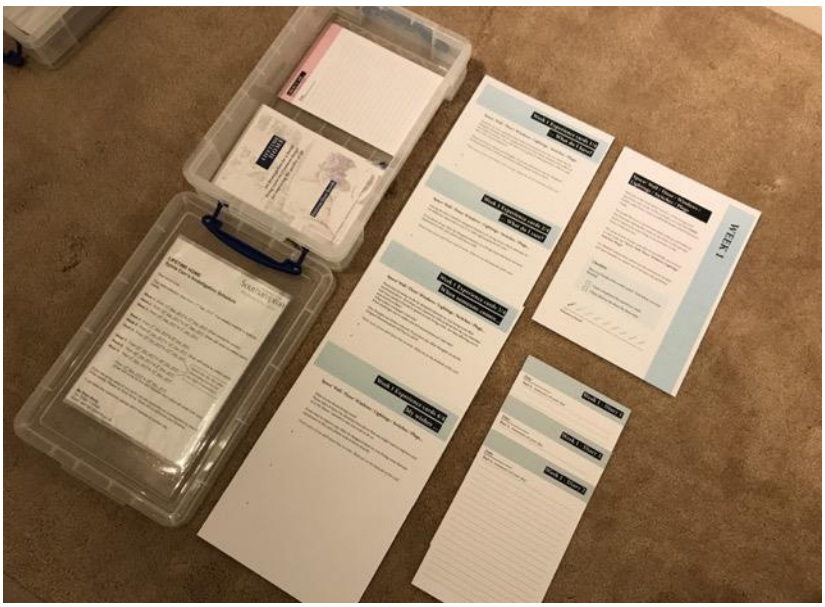

Figure 3.3 The culture probe pack of the user study

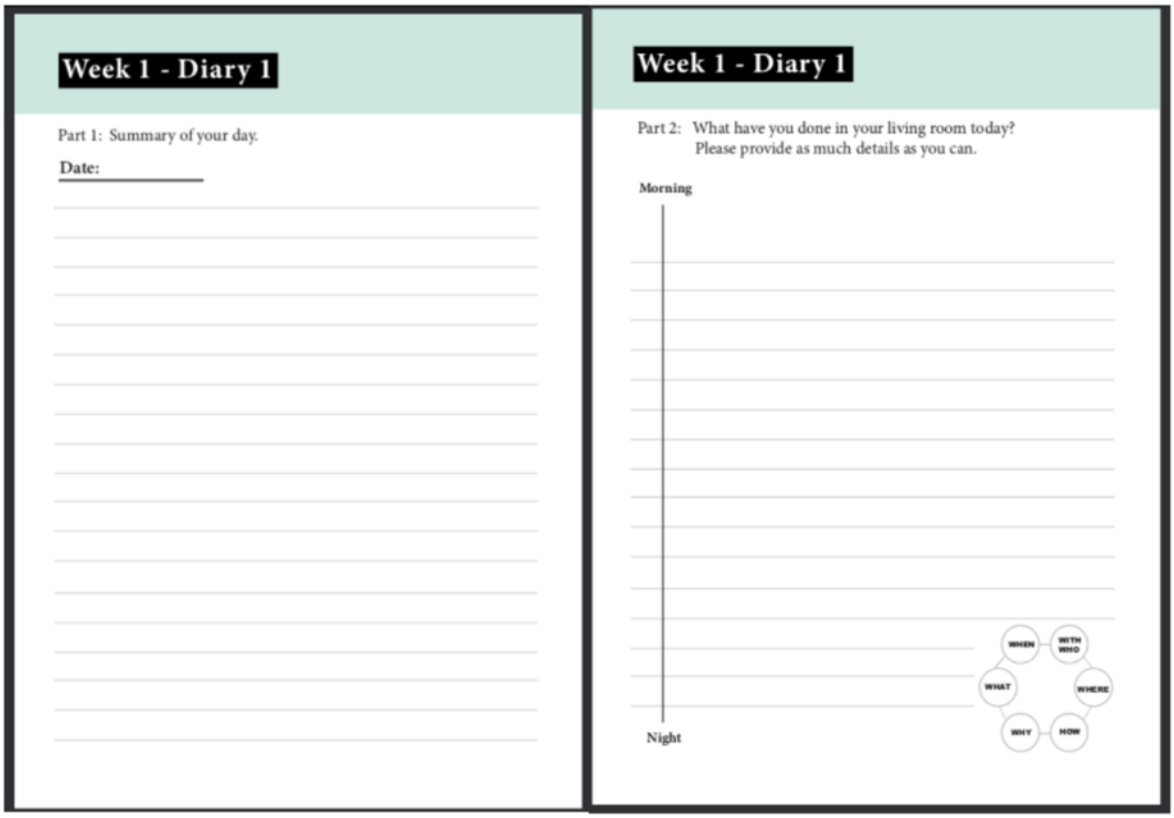

Figure 3.4 The diary cards of week one

3.3.1.4 Content of diary cards

The diary cards are designed for a better understanding of older people's daily activities. After the pilot study, the author updated the diary card with the new design version (figure 3.4). Each week participants were asked to fill in three diaries, each diary with two pages. The front page (left hand of figure 3.4) is designed to ask for a participant summary of their day. The back page (right hand of figure 3.4) is designed to ask "What have you done in your living room today?" in the living room. Participant knew that they could write one or more activities in this section but needed to have details. In order to guide them to write the living room activities as detailed as possible, the 5W1H user scenario model appears on each card. The aim of the design of the diary card was to gain information on 1) participants' social activities, and 2) participants' living room activities, in detail. For example, if a participant wrote they had a coffee in the living room, they were asked to write details such as 1) when you have the coffee 2) where you sit to have the coffee 3) who you have the coffee with 4) how's the process of having the coffee 5) why you want to have coffee during this time?

3.3.1.5 Camera and voice recorder

In the cultural probes packet (figure 3.5), a digital camera and a voice recorder have been prepared for participants who have difficulties with writing so they can record their experience via the camera and voice recorder instead of writing.

Figure 3.5 The culture probe packet

3.3.2 Direct video-based observation

Beside the cultural probe approach, the user study also conducts the direct-video observation method. Ethnographers usually spend extended periods observing the phenomena in which they are interested in and making extensive fieldnotes about their observations (Hammersley and Atkinson 1995). For this study, as well as observation, the author also used video to record living room life. Visual and audio-visual methods are a useful way of 'getting at' practices which are difficult to articulate or to convey through methods which rely on language (Sweetman 2009; O'Connell 2012). Moreover, video-based observation has been chosen in this research, because it allows the author to collect rich and systematic digital data from older people's ongoing activities (Berg and Lune, 2012; Carthey, 2003). Therefore, older people's movements, actions, and behaviours can be captured to discover their nonverbal and indisputable real life (Mohamaddan et al., 2014; Kawulich, 2005). Additionally, the video recorded materials help the author to verify details to eliminate the weaknesses of direct observation (Asan and Montague, 2014; Jeffcott and Mackenzie, 2008) and to improve the quality of the data collection (Schmuck, 2006). It has been confirmed that by using fixed

position cameras the video-based observation is effective for researching people's interaction in a single room (Asan and Montague, 2015). Meanwhile, the impact of the author's subjective bias on research analysis can be reduced (Denzin andLincoln, 2011). Therefore, the video-based observation method was planned to explore the older people's actual day-to-day activity behaviour in their living room environment, which include situations of their own activities and activities with other people such as family and friends. After analysing the participant video-based observation and non-participant video-based observation (Parke and Griffiths, 2008; Sparrman, 2005) and considering the limitation of the observation, participant video-based observation was the chosen approach. This allows the author to gain empathy through participants' experiences and behaviours, therefore gaining insight into their meaning (Wortham, 2010; Adams and Cox, 2008). Thus, it helped the author to understand the targeted older people's experiences in their living room under different scenarios.

Video-recording and direct observation extended the possibilities of each of these techniques and overcame some of the limitations of each individual method (Paterson et al. 2003). For example, video recording observations overcame the potential loss of finer level detail which occurs when relying on researchers writing up their fieldnotes after a period of observation (Creswell 2007). Video recording observations allowed us to look back, to replay and to discuss emergent themes and nuances of the author-participant-living room interaction which might not be seen in other methods. Determining what, when and who to record /observe/document within each household was an important issue (Power 2003). We did not want to record extensive footage which would be impossible to view or analyse within the confines of the project timetable (Martens 2005) but we wanted to record a range of practices, moments and interactions involving all those within a household.

The limitations of observational research are that it mainly reflects people's behaviour and body motion but does not help with reasons behind the behaviour and people's thinking process and emotional feeling during the observation (Parke and Griffiths, 2008). In addition, because of privacy and research ethics, it is difficult for the author to set up consistent video-based observation 24/7 in a participant's living room. Thus, an in-depth interview approach was applied to explore participants' feeling and experience that were not captured by the video observation and cultural probe cards.

Data sources-video observation: The author would stay with the participant(s) at least three hours in their living room. The participant is mainly leading the activity in these three hours.

All activities were recorded by go-pro camera. Finally, video data collected for each household are between three to eight hours.

3.3.3 In-depth Interview

The final method in the user study is the in-depth interview. An in-depth interview is one the most popular methods in qualitative research and is widely applied in the academic area. It helps researchers to collect accurate and inclusive data through participants' opinions and their description of experiences (Opdenakker, 2006). It also offers opportunities for researchers to investigate new ideas and to develop new dimensions of a research issue based on the people's own experience (Stanton et al, 2013).

During the interview, a number of questions were prepared with a specific interview guide to ensure a smooth interview process with participants. Both closed-ended and open-ended questions were designed in the interview. Closed-ended questions were designed to explore participants' demographic background, such as "How long have you been living in this property?", "How many people in your household?", etc. Open-ended questions focused on older people's experience with their living room, such as "How do you think the furniture arrangement in your living room?", "How easy/difficulty is it to open windows in your living room?", etc.

Data sources-Interview: In the interview for the first home visit, participants were invited to talk about their life, health conditions, home, living room modification in recent years. The second interview was after the second home visit video observation. Participants were invited to talk about what they think about their living room environment in regards to doing particular activities that happened during the video observation. A semi-structured schedule was used to begin the conversation but adapted if the participant chose to deviate from it. The third interview happened in the final home visit; the author and participant reviewed the materials collected from the cultural probe and discussed themes of interest. All interviews for one participant lasted 90-180 minutes, were recorded and transcribed in full.

Other data sources- sketches and note: the author has drawn sketches with size measurements of each participant's living room, including details of vertical and horizontal decoration (position of objects on floor and wall); windows and handles. After each home visit, the author made notes of incidents and events that occurred during the visit.

3.3.4 Methodological triangulation and data evaluation

This research adopted methodological triangulation to investigate the older people's experience in their living room at home. Methodological triangulation involves the use of more than one research method of data collection about the same phenomenon (Carter et al, 2014; Flick, 2004; Oppermann, 2000). For this research, research triangulation includes interview, video observation and culture probe methods (figure 3.6) to collect researcher-driven, participant-driven and natural phenomenon data. Many researchers have highlighted the benefit of using the triangulation method to over-come problems of bias and validity (Carter et al, 2014). As I discussed above, all methods have their benefits and weakness, triangulation attempts to avoid the biases and improve the validity of the data. For example, even though the author used an unobtrusive, small video recording device (Go-pro), to collect observational data of the participants in their homes, participants' behaviour is still inevitably disturbed by the researcher's presence. The researcher cannot know what the participant is thinking either, by the video data alone. Therefore, after the video observation, the author reviewed the video with participant and did a further interview to try to understand their behaviour and motivations. Moreover, through the cultural probe approach, the author could collect the participants' own thoughts about their living room over an extended period of time, capturing changes that may occur over days/weeks. Collected materials from the research include audio data (from interview), video data (from observation) and text data (from culture probe). All data was transcribed into text data before conducting the content analysis and used in the finding chapters (chapter 4 and chapter 5). Moreover, the interview and cultural probe data (collected from participants) helped the author analyse the video data (collected from the author) to avoid subjective understanding from the author. Therefore, the triangulation method of this research will support each other from data collection to data analysis.

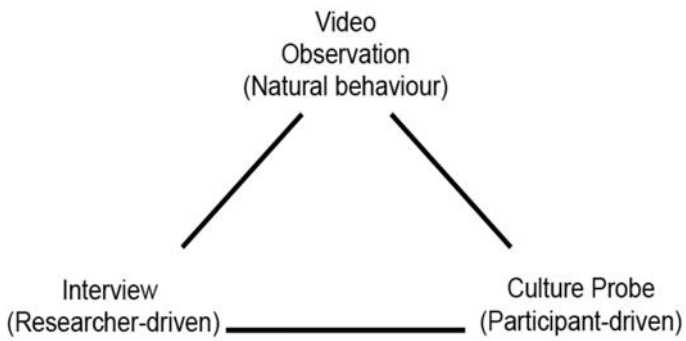

Figure 3.6 Method triangulation of this project

Moreover, to ensure accurate collection of data from the ethnographic user study, a spiral data collection approach was developed (figure 3.7). This model has been used in many action studies, such as teaching (Moghaddam, 2007) and technology research (Tulinius and Hølge-Hazelton, 2011). According to Kemmis (1988), ‘‘action research consisted in analysis, fact-finding, conceptualization, planning, execution, more fact-finding, or evaluation; and then a repetition of this whole circle of activities; indeed a spiral of such circles’’. Following the spiral circles to collect data can avoid the researcher's potential subjectivity bias (Moghaddam, 2007). Moreover, it can help the researcher to remain objective while doing research (Ladkin, 2005).

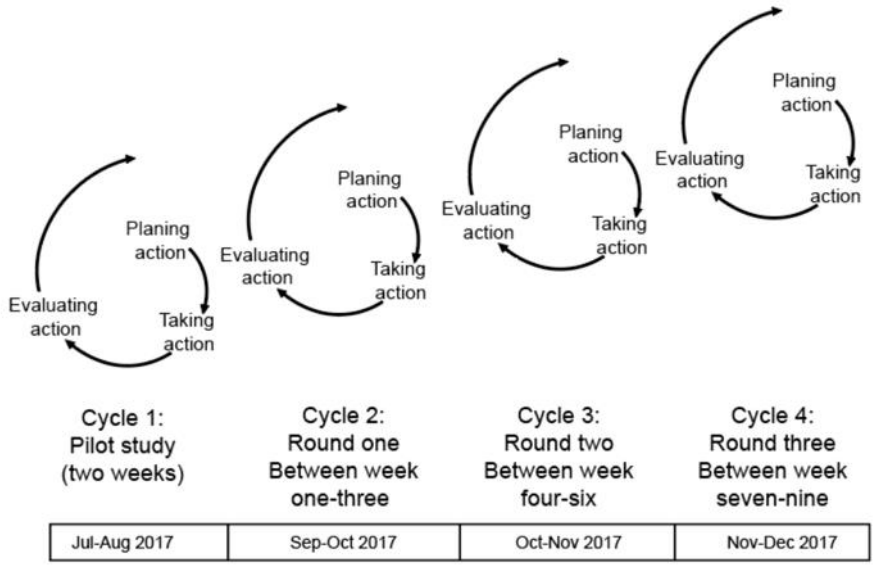

Figure 3.7 Spiral data collection cycle of this project

For this project, the author used a spiral cycle to over-come the bias from data collection. The author designs the content of data collection before went to older people's home, after collected materials from older people through interview, video observation and cultural probes, the author analgised the data with literature review and existing theories. To reduce the elimination of error and subjective bias, the author did a pilot study before the main data collection. Details and results of the pilot study will explain in the following section 3.7. Although the content of experience cards and diary cards are pre-designed and be repeated in round one, two and three during the data collection, it still could help the author to control the valid information collected from participants. The reason is because of the participant has improved their knowledge and thinking of living room experience after author's each home visit. Moreover, the author will

change the action plan to fit with each participant before the home visit, such as the questions of the interview, measure the content on the experience cards and give them suggestions or guidelines. The details of ethnographic user study procedure of this project will introduce in the next section.

3.3.5 Procedure of ethnographic user study

Participant engagement with the ethnographic user study was planned with five parts over a nine-week period. The visualized whole process is attached in Appendix 5

Part one: The Personal Background semi-structured interview and Living Space observation (week one). The first interview schedules are attached in Appendix 6.

Part two: Two video-based observations (at week two and week four)

Part three: Two in-depth interviews after each observation (at week two and week four). The second interview schedules are attached in Appendix 7.

Part four: Nine-week cultural probe experience and diary cards (collected at week nine)

Part five: End with the Final In-depth interview (at week nine). The third interview schedules are attached in Appendix 8.

Overall, the research consisted of four researcher visits to the participant's home during the nine-week ethnographic user study (Appendix 5). Once the older people agreed to participate in this research, they were sent a project information sheet and consent form before the first visit date. Clear goals were set up for each of the four visits:

Visit one: The goal for the first visit was to let the participant understand the user study background and process and collect participants' background information. Details of Cultural Probes packet was explained and demonstrated to the participants as well.

Visit two: The goal of the second visit was to observe how older people use the living room with friends or families.

Visit three: The goal of the third visit was to observe how older people carry out activities alone in the living room.

Visit four: The goal of the final visit was to collect the Cultural Probes materials from the participants and explore the ideas and inspirations for improving living room from the participant after the six-week ethnographic study.

The next section will introduce the research procedure on how these methods were used in older people's living rooms. The Fieldwork procedure for this research is listed in Appendix 9.

Before each visit

Before each visit to the participant's home, the author contacted the participant and double-confirmed the date and time for the visit and checked the participant's health condition was good enough to do the interviews and observations. The author prepared all materials, checked research equipment (such as if batteries were fully-charged) and other settings of the equipment to ensure a smooth data collection process.

During visit - First visit

To achieve the goal of the first visit, the process followed is described below.

a) A brief introduction for this research project and the process of the first visit was explained to the participant. Participant signed the consent form.

b) A semi-structured interview, based on the Personal Background Interview Schedule, was conducted (See appendix 6). This interview took around 40 minutes.

c) Introduction of the Cultural Probe Packet to the participant, which included experience cards, camera and voice recorder. The first week experience cards were left with the participant.

Living room observation by the author based on Living Space Observation schedule (See appendix 10). This included sketch, notes, pictures and measurements of the participant's living room size. This took around 20 minutes. Two examples of the sketches are attached in Appendix 11.

d) Video position test. The author tested where the best position was to set up the GoPro camera for the next video-based observation.

During visit- Second visit. Participant video-based observation

The second visit focused on the participant video-based observation and an in-depth interview. The author acted as a guest to visit a participant in a natural way. Types of activities were lead by the participant, such as talking, drinking tea, watching TV or doing anything the participant wanted to do with the author. To achieve the goal of the second visit, the research procedure details are described as below.

a) The second visit started with a brief introduction of the purpose and procedure of this visit and the participant was invited to sign the consent form for the video observation. After that, the author set up the GoPro(s) to the selected position(s) tested during the first visit.

b) The participant video-based observation then started when the participant was ready. The video-based observation lasted two to three hours.

c) Post observation in-depth interview was then conducted based on the Interview Schedule (See appendix 7). When necessary, the author replayed the video recording to the participant as a reminder of their behaviour. This interview took around 40 minutes.

d) The first week experience cards were taken by the researcher, along with any pictures taken by the participant. After that, the participant was given the next two weeks' experience cards and asked about the activity they might like to share for the third visit. A date for the third visited was arranged and the participant was briefed on how the non-participant observation would work.

During visit- Third visit. Non-participant video-observation.

The third visit focused on non-participant video-based observations and an in-depth interview. During the non-participant observation, the author tried to avoid any disturbance to the participant. The author made notes quietly in order to not let the participant feel uncomfortable. To achieve the goal of the third visit, process details described as below.

a) The visit started with a brief introduction of the third visit procedure. The participant was invited to sign the consent form, and the GoPro(s) was set up ready to start the non-participant observation.

b) During the non-participant observation, the researcher tried to avoid communicating with the participant during the whole observation process, unless the participant directly asked.

c) Post observation in-depth interview following the In-depth Interview Schedule was then conducted (Appendix 7). If necessary, the author replayed the video recording to the participant as a reminder of their behaviour. This interview took around 40 minutes.

d) The second and the third week experience cards were collected, along with any pictures that were taken by the participant. After that, the author gave another two weeks' experience cards to the participant. Finally, the fourth visit date and time was confirmed.

During visit- Fourth visit

The fourth visit mainly focused on a semi-structured interview to collect more feedback from participants' perceptions of the project. The process followed is described below.

a) The participant was briefed on the procedure of the fourth visit and invited to sign the consent form.

b) The interview followed the pre-designed Final Interview Schedule (Appendix 8) and it took around 40 minutes.

c) The fourth, fifth and sixth week experience cards were collected, along with any pictures taken by the participant. Participants were asked about their reasons for taking the pictures.

Finally, the participant was given £50 reward for his/her cooperation and contribution to the data collection.

After each visit

After each visit, all recorded materials (including observational video recording, interview audio recording, pictures taken during a visit, researcher note, and any other materials) were transferred to the author's laptop. To avoid technical error, the recorded data was also backed-up to a hard-drive. To ensure data safety and confidentiality, both the author's laptop and hard drive was password protected and only the author could review the original data. This data will only be used for academic research. Moreover, the author evaluated the collected materials and

transcribed the collected materials into the text documents. An overview of the whole procedure of the ethnographic user study and materials collect from participants are listed in table 3.3.

Table 3.3 Overview the whole procedure of the ethnographic user study and materials collect from participants

Week of the project	Number of respondents	Methodology
Week 1	9	Background interview and experience cards on space
Week 2	8 (1 dropout*)	Experience cards on furniture
Week 3	8 (1 dropout*)	Experience cards on atmosphere
Week 4	9	Video observations and unstructured interview with 2 participants and stage 2 collection of experience cards on space after sharing the video observation
Week 5	7 (2 dropout*)	Video observations and unstructured interview with 2 participants and stage 2 collection of experience cards on furniture after sharing the video observation
Week 6	7 (2 dropout*)	Video observations and unstructured interview with 4 participants and stage 2 collection of experience cards on atmosphere after sharing the video observation
Week 7	8 (1 dropouts*)	Stage 2 collection of experience cards on space
Week 8	7 (2 dropout*)	Stage 2 collection of experience cards on furniture
Week 9	7 (2 dropout*)	Stage 2 collection of experience cards on atmosphere
Week 10-12	7 (2 dropouts*)	Final in-depth interviews based on the experience cards and their reflections during this project period

* The three dropouts include two participants whose experience cards were recorded by the author.

3.4 Content analysis

3.4.1 Theory of content analysis

Table 3.4 Characteristics of qualitative content analysis category (adapted by White and Marsh, 2006)

Research approach	Inductive; research questions guide data gathering and analysis; potential themes and other questions may arise
Research tradition or orientation	Naturalist or humanist; hermeneutics
Objective	"To capture the meanings, emphasis, and themes of messages and to understand the organization and process of how they are presented" (Altheide, 1996, p. 33); "Search for multiple interpretations by considering diverse voices (readers), alternative perspectives (from different ideological positions), oppositional readings (critiques), or varied uses of the texts examined (by different groups)" (Krippendorff, 2004, p. 88)
Data: Nature	Syntactic, semantic, or pragmatic categories; naturally occurring texts or text generated for project
Data: Selection	Purposive sampling to allow for identifying complete, accurate answers to research questions and presenting the big picture; selection of data may continue throughout the project
Categorization schema	Coding scheme usually developed in the process of close, iterative reading to identify significant concepts and patterns
Coding	Subjective; in some cases, use of memos to document perceptions and formulations; techniques for increasing credibility, transferability, dependability, and confirmability of findings
Argument basis	Deep grounding in the data; if numbers are presented, they are usually presented as counts and percentages; description of specific situation or case accurately and thoroughly; may involve triangulation based on multiple data sources for same concept; may use techniques to develop grounded theory to relate concepts and to suggest hypotheses that can be tested deductively; presentation "Support[s] interpretations by weaving quotes from the analyzed texts and literature about the contexts of those texts into their conclusions, by constructing parallelisms, by engaging in triangulations, and by elaborating on any metaphors they can identify" (Krippendorff, 2004, p. 88)
Use of computers	As annotation and searching aids; representative software: Atlas. TI or Nvivo

The content analysis approach was applied to achieve objective 4, which identified the risks and challenges that older people face in their living room at home under different scenarios. The fundamental features of the content analysis have been summarized in table 3.4.

Content analysis approach has been defined as a flexible and reliable qualitative research method to analyse text data that has used widely in ethnographic studies (Cavanagh, 1997; Altheide and Schneider, 2012) for user behaviour and cultural studies (Seale, 2004). Therefore, it helped the author to systematically and intensively analyse the data collected from the ethnographic user study in order to explore older people's explore living room experience and

figure out risks and challenges that older people face at home. Secondly, the principal strength of this method is that it categorises the recorded digital and textual materials into clear categories and systematic study as a basis for making the specific interpretation, inferences, and analysis (Mayring, 2014; Mayring 2009； Weber, 1990). Therefore, it could help the author to classify the large amount of video, images, audio, experience cards and notes into efficient categories to get reliable results by analysis. Thirdly, the content analysis puts emphasis on empirical content rather than interpretative arguments that can be help avoid impressionistic, subjective and superficial analysis (Weber, 1990). Therefore, it allows the author to obtain a deeper understanding of how older people use their living room and how the interaction occurs between living room layout design, furniture arrangement and atmosphere when they do different activities under different scenarios. Consequently, in this research, content analysis approach was used to analyse the materials collected through narrative responses, interviews, video-based observation, and cultural probe experience cards.

The process of content analysis can be divided into five steps, a) data transcribing b) information compiling, c) data coding, d) data clustering and e) obtaining information from data. To make sure the data collection and transcription are high quality, accurate and without mistakes, the author checked every process of transcribing of the data, through entry, coding, digitisation and validation.

Results from the content analysis contribute to establishment of a list of risks and difficulties that older people face in their living room in different scenarios. Based on the findings, a design insight to improve older people's living room experience was developed.

3.4.2 Analytical approach of this research

Table 3.5 Analytical approach of this research

Methodology (research conducted from 8/2017-12/2017)	Justification and advantage of the methods	Analysis methods
Experience cards on space +diary (Stage 1)	The implementation of diary and experience cards can help the author to grab information from a superficial physical living room setting to a deeper emotional insight regarding specific older people's interactions (Gaver et al, 2004; Mattelmäki et al, 2002). It also helps the author receive open-ended and unbiased opinion from participants over a period of time (Creswell and Poth, 2017).	Content analysis approach has been defined as a flexible and reliable qualitative research method to analyse text data that has used widely in ethnographic studies (Cavanagh, 1997; Altheide and Schneider, 2012) for user behaviour and culture studies (Seale, 2004). Therefore, it will help the author to systematically and intensively analyse the data collected from the ethnographic user study in order to explore older people's living room experience and figure out risks and challenges that older people face at home. Secondary, the principal strength of this method organises the recorded digital and textual materials into clear categories and systemic study as a basis for making the specific interpretation, inferences, and analysis (Mayring, 2014; Mayring 2009； Weber, 1990). Therefore, it can help the author to classify the large amount of video, images, audio, experience cards and notes into efficient categories to get reliable results by analysis. Thirdly, the content analysis emphasises empirical content rather than the interpretative arguments that can be avoided of impressionistic,
Experience cards on furniture +diary (Stage 1)		
Experience cards on atmosphere+ diary (Stage 1)		
Video observations	This allows the author to collect rich and systematic digital data from older people's ongoing activities (Berg and Lune, 2012; Carthey, 2003). Therefore, older people's movements, actions, and behaviours can be captured to discover their nonverbal and indisputable real life (Mohamaddan et al., 2014; Kawulich, 2005). Additionally, the video recorded materials will help the author to verify details to eliminate the weaknesses of direct observation (Asan and Montague, 2014; Jeffcott and Mackenzie, 2008) and to improve the quality of the data collection (Schmuck, 2006).	
Video observations		
Video observations		

Unstructured interview following video observations	After the video observation, the unstructured interview allows the author to gain empathy through participants' experiences and behaviours, therefore, to get insight into their meaning (Wortham, 2010; Adams and Cox, 2008). Thus, it helps the author to understand older people's experience in their living room under different scenario.	subjective and superficial analysis (Weber, 1990). Therefore, it allows the author to obtain a deeper understanding of how older people use their living room and how the interaction between living room layout design, furniture arrangement and atmosphere differs when they doing different activities under different scenarios from the data collection to content data analysis. Consequently, in this research, content analysis approach is used to analyse the materials collected through narrative responses, interviews, video-based observation, and cultural probe experience cards. The process of content analysis can be divided into five steps, a) data transcribing b) information compiling, c) data coding, d) data clustering and e) obtaining information from data. To make sure the data collection and transcription are high quality, accurate and without mistakes, the author will check every process of transcribing of the data, through entry, coding, digitization and validation.
Experience cards on space +diary (Stage 2)	It will help the author get more critical thinking of participants' living room. The repeat questions during different periods could get more fresh ideas basic on what the participants do during these weeks.	
Experience cards on furniture +diary (Stage 2)		
Experience cards on atmosphere +diary (Stage 2)		
Experience cards on space +diary (Stage 3)	After the video observation, participants get more thinking time and inspiration for their living room environment. The repeated stage 3 could get more information from them.	
Experience cards on furniture +diary (Stage 3)		
Experience cards on atmosphere +diary (Stage 3)		
In-depth interview	It helps the author to collect accurate and inclusive data through participants' opinions and their description of experiences (Opdenakker, 2006). It also offers opportunities for the author to investigate new ideas and to develop new dimensions of a research issue	

	based on the people's own experience (Stanton et al, 2013).	
Observation of adaptations	It helps the author observe the physical environment directly. 1)It could collect empirical data. 2) Get Inter-rater reliability, and 3) there is no problem with participant self-reports bias.	

The above table present the overview of the materials collected from the ethnographic user study. The Main data collection conducted between Aug. 2017- Dec. 2018. All of the experience cards data was combined by stages. As some respondents in stage 1 discussed week 1 topic in Week 2 and 3 and week 2 topic in week 3, decision was made to combine all the three experience card data. However, the themes were analysed within by space, furniture and atmosphere.

First the experience cards of the stage 1 and diary cards were transcribed to analyse the data using the content analysis method. Content analysis approach has been defined as a flexible and reliable qualitative research method to analyse text data and is used widely in ethnography studies (Cavanagh, 1997; Altheide and Schneider, 2012) for user behaviour and cultural studies (Seale, 2004). Therefore, it helped the author to systematically and intensively analyse the data collected from the ethnographic user study in order to explore older people's living room experience and figure out risks and challenges that older people face at home.

Video observations were analysed later using visual analysis. The principal strength of this method organises the recorded digital files into clear categories and systematic study as a basis for making the specific interpretation, inferences, and analysis (Mayring, 2014; Mayring 2009；Weber, 1990). Therefore, it helped the author to classify the large amount of video, images, and notes into efficient categories to get reliable results by analysis.

Then the unstructured interviews following the video observations were transcribed and analysed again using content analysis. Then stage 2 and stage 3 data on experience cards were transcribed and analysed using content analysis methods. Finally, transcribed data from in-depth interviews were analysed using content analysis. In addition to all of these methods, observations of adaptations by the interviewee were used to see some of the actions the

respondents took following the reflection on the issues in the living room in relation to space, furniture or atmosphere.

3.5 Sample strategy

Many researchers have highlighted that the sampling strategy plays an essential role for a qualitative research practice and that can determine research efficiency and validity (Sandelowski, 2000; Öhlén 2011, Morse, 2016). Moreover, it has been confirmed that the stratified purposeful sampling techniques can help researchers to clarify the sample and to collect valuable data that accurately reflect the population (Wilmot, 2005; Sandelowski, 2000). Therefore, the participants for this research were approached by using stratified purposeful sampling techniques. Sample characteristics were identified after researching existing knowledge on the living situation in the UK. Moreover, in terms of number of participants for this project, the minimal sample size for ethnographic qualitative research could be as little one person that adequately answers the research question (Marshall, 1996). To ensure enough data could be gathered to support the research need, this research targeted a minimum of two participants for the pilot study and six participants for the main data collection.

The factors that may influence older people's living habits and experience at home formed the characteristics of participants for this project. Those factors have been discussed in chapter one that including house type, household type, residents age range, and residents' gender. After considering different characteristics of participants. The ideal plan for participant recruitment was to cover each characteristic show in table 3.6.

Table 3.6 the ideal sample plan of this research

		Household type	
		Single household	Couple household
House type	House	Age 65-75: one male, one female Age 76-85: one male, one female Age 85+: one male, one female	Age 65-75: one household, Age 76-85: one household Age 85+: one household

	Bungalow	Age 65-75: one male, one female Age 76-85: one male, one female Age 85+: one male, one female	Age 65-75: one household Age 76-85: one household Age 85+: one household
	Flat	Age 65-75: one male, one female Age 76-85: one male, one female Age 85+: one male, one female	Age 65-75: one household Age 76-85: one household Age 85+: one household

The promotional campaign for participant recruitment was firstly leaflets. The leaflets were distributed through elderly communities, such as the local Age UK branches (both in Winchester and Southampton), a group of housing services for older people through Southampton City Council, and other communities (such as churches). The leaflet was used to introduce the content of this research project and the author's contact details for better communication.

Finally, twelve participants were recruited in this research from Southampton, Winchester, Christchurch and Bournemouth. There were five households living in flats (two couples, three single), four households living in bungalows (three couples, one single), and three households living in houses (two couples, one single). Due to health issues, one participant withdrew after week one, so her data was not included in this research. Finally, the data covered eleven participants. Of these eleven participants, six collected all of the data (that includes nine weeks' cultural probe, video observation and three interviews); they were participant 3, 4, 5, 7,9 and 10. The rest of them collected partial data due to health conditions (as shown in table 3.7).

Table 3.7 Final data collection sample characteristics

Name	Age	Region	Person	Dwelling type	Living arrangment	Full data
P01	88	Southampon	Ego (wife)	Flat (owned-purpose built)	Couple	6 weeks Cultrual probe, full of others
P02	88 & 89	Southampon	Mary (write) Jim (interview)	Flat (owned-purpose built)	Couple	3 weeks Cultrual probe, full of others
P03	82	Winchester	Ego	Flat (Rented- residential block)	Single	Full data
P04	78	Christchurch	Ego	Flat (owned-purpose built)	Single	Full data
P05	77	Christchurch	Ego	Flat (owned-non-purpose built)	Single	Full data
P06	70	Christchurch	Ego (wife)	Bungalow	Couple	3 weeks Cultrual probe, full of others
	70	Christchurch	Ego (wife)	Bungalow	Couple	1st home interview + video observation
P07	73 &83	Bournemouth	Ego (wife, husband write separate diaries)	Bungalow	couple	Full data
P08	92	Christchurch	Ego (researcher help to write)	Bungalow	Single	Visti 5 times + semi-structured interviews
P09	78	Christchurch	Ego (wife)	House (rented-Semi-war house)	couple	Full data
P10	74	Bournemouth	Ego (wife)	House (owned-detached)	couple	Full data
P11	99	Hedge End	Friend + Ego	House (Owned-detached)	Single	Visit twice + semi-stuctured interviews

3.6 Research ethics

Research ethics approval was applied for both secondary data analysis and the ethnographic user study data collection through the University of Southampton ethics committee.

In terms of secondary data analysis, ethical approval was sought and obtained from the University of Southampton ethics committee. The reference for the ethics approval is 23304. Furthermore, in order to download the dataset through EHS website, it requires users to fill in the registration information with the name, organization name, a brief introduction or the project (only for non-commercial use) and email address. For this newest dataset, it asks to apply for a special license from DCLG, it is free to download once the application passed. Data and documents can be downloaded from the data files section from the website:

https://discover.ukdataservice.ac.uk/catalogue?sn=8067, and

https://discover.ukdataservice.ac.uk/catalogue?sn=8068,

In terms of the ethnographic user study, the author achieved ethics approval through the University of Southampton. Moreover, this research was conducted using linked anonymity. Participants were coded and remain anonymous in data transcription from video-based observation, in-depth interview and cultural probe tasks cards. Moreover, the participant confidentiality will continue to be maintained. The data was only used and analysed by the author, and only shared with supervisors for discussion purposes. All ethnographic data and research result data were stored in a secured laptop with confidential log in password that only the author could access.

3.7 Pilot study and feedback

Before the main data collection of the ethnographic user study, the author conducted a pilot study with the purpose of testing the adequacy, feasibility of the nine-week user study (Connelly, 2008). Pilot study is defined as a small, preliminary study for helping to test the feasibility of a further confirmatory study (Arain et al, 2010). Van Teijlingen and HundleyThe (2001) indicated the important reason for undertaking a pilot study was assessing and testing whether the developed research plan is adequate, realistic and workable. Therefore, the author conducted a pilot study with purposes of 1) testing whether the designed ethnographic user study provided appropriate and readable information, 2) testing whether the participants

understood the content of each methods from the user study, and 3) testing whether the author could gain expected answer from participants for the further data analysis.

Table 3.8 Samples of the pilot study

		Age	Couple/Single	House/Bungalow/Flat
PILOT	PP1	88	C	F
	PP2	70	C	B
	PP3	82	S	F

The pilot study of this research involved three samples from Southampton, Winchester and Christchurch. In order to cover the variety of the samples, pilot study samples included couples and singe household, living in house and flat (Table 3.8). The pilot study was conducted between July 2017 and August 2017 over three weeks. The procedure of the pilot user study was conducted by the preliminary designed data collection procedure. The content of the pilot user study included experience cards, diary cards, video observation, and in-depth interview. The preliminary designed version of the user study covered various materials that included:

- In-depth interview schedules
- Instruction booklet to introduce how to use the cultural probe pack
- Living room inspection cards (later updated the term to Experience cards)
- Diary cards
- Digital facilities that used for video observation

During the pilot study, the author set up several tasks as below:

- Asked for participants' feedback on how clear and simple the instruction booklet was.
- Asked for participants' feedback to identify any questions that were difficult to understand on the inspection cards.
- Assessed whether participants provided an adequate range of ideas on the inspection cards and diary cards.

- Checked that participants answered all questions on inspection cards.
- Recorded the time taken to complete the interview and decided whether it was reasonable.
- Tested the go-pro camera during the video observation and made sure it could capture the participants' actions in the living room.

After collecting the pilot study data, the author:

- Identified questions that were difficult for participants to understand during the in-depth interviews.
- Assessed whether participants provided an adequate answer through interviews.
- Established that responses from participants were expected.
- Ensured the collected data could be used for future data analysis.

Based on the feedback from the pilot study, the author:

- Discarded all unnecessary and ambiguous questions on the inspection cards.
- Discarded all unnecessary and ambiguous questions from interview schedule.
- Re-worded and re-designed the instruction booklet, inspection cards and diary cards.
- Re-worded and re-designed questions for the interviews.

Figure 3.8 shows the example of the notes from the pilot study and the update point. Figure 3.9 shows an example update after the pilot study. The author found that pilot participants struggled with knowing how to start writing the experience cards. Therefore, the update version of the experience cards has hints on the back of the cards 1) to give inspiration, 2) encourage participants to write more, and 3) to guide participants to write the correct content.

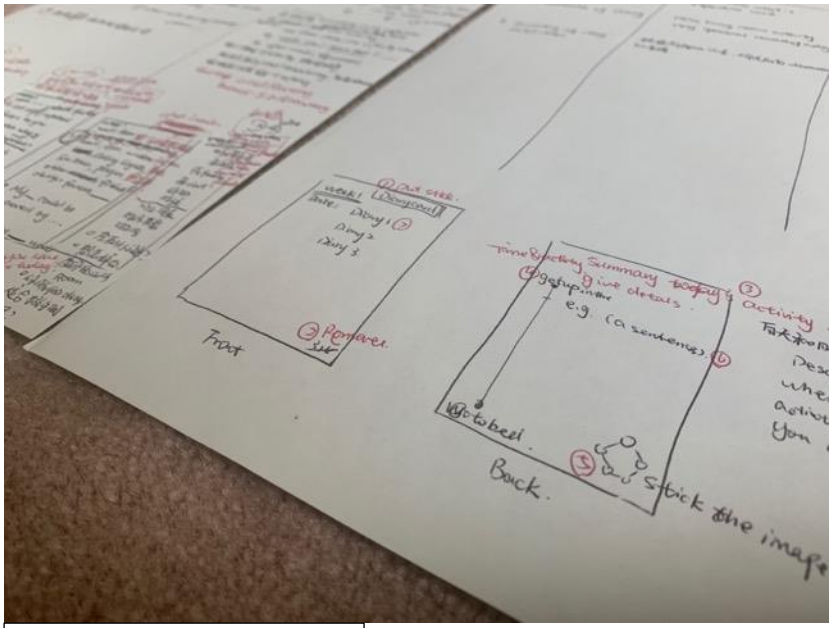

Figure 3.8 Notes from pilot study

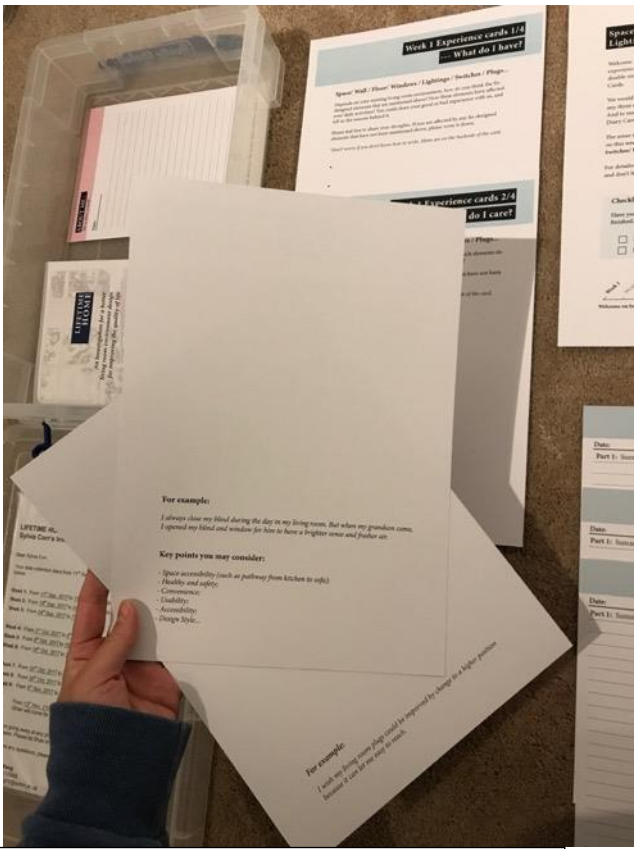

Figure 3.9 one of the update points from the pilot study

3.8 Conclusion

This chapter has focused on the selection of appropriate methods for this research. This chapter also concentrates on methodological design and presents the detailed process for this study. An ethnographic user study method was employed for this project. Results from the English Housing Survey have been analysed to explore the current living situation for older people in the UK and to develop the stratified purposeful sampling strategy for qualitative methodology. The ethnographic user study approach was employed to explore people's natural behaviour with multiple activities in their living room through video-based observation, in-depth interview and cultural probe. Qualitative content analysis has been applied to analyse collected data, and in turn, to identify key factors that have an impact on older people's living experience in their living room. The next chapter will discuss the details of research findings.

Chapter 4 The requirement and design insights of living room space design to meet older people's age-related change

4.1 Introduction

There are many benefits to aging in place, but older people may face some challenges. One of these is whether their home is designed in such a way as to ensure their comfort and safety in all areas. Even the larger spaces, such as living rooms, can present hazards for older people, especially if they face physical challenges getting around. This chapter will explore three research questions, 1) what are the current space design challenges and issues among older people in the living room, 2) what are the reasons behind the challenges and issues, and 3) to what extent the living room space design can meet older people's requirement due to their age-related change. The chapter draws on the data collected from the ethnographic study including in-depth interviews, cultural probes, and video observations. All data are transcribed into text version and analysed based on the conceptual framework presented below (Figure 4.0). Space (Structure) related issues in the living room and older people's age-related change is discussed. Then some design insights are provided in response to the need to design older people's living rooms around their own requirements.

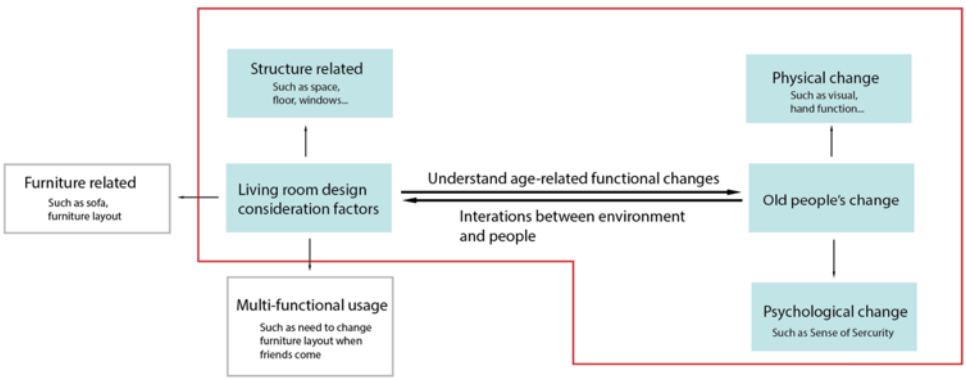

Figure 4.0 Focus on Chapter 4

Space design in this chapter is defined as design elements that cannot easily change or move in a living room, such as the shape or size of the room, flooring and walls, doors, windows and switches or sockets on the wall. The following section will present the findings and discussion for each of the following; 1) Size and structure of the living room , 2) Floor and wall design of

the living room, 3) Door pathway and door design of the living room, 4) Windows of the living room, and 5) Sockets and switches of the living room.

4.2 Size and structure of the living room

The size and structure of the space has an impact on the way older people plan and lay out the furniture in their living room. Research findings show that the shape and size of the living room influenced older people's living room layout design and experience, such as how they: 1) layout their furniture, 2) select their furniture and adaptation products, and 3) create routes around the living room.

4.2.1 Findings

In the user study, five participants' living rooms were rectangular, four participants had square living rooms and two were L-shaped. The participants utilised their living room space in various ways to create a comfortable and relaxing space based on their individual needs, even when their living rooms were similar shapes and sizes.

Figure 4.1 Two-piece sofa of Participant 1

Size of the living room and effect on the usage of furniture and product

The size of the living room limited the way older people selected furniture. Participant 1 complained that due to the limited size, her living room space could not allow her to buy an appropriate settee for visitors, with a suitable colour and materials to fit their existing design style and L-shaped to fit her existing layout. Alternately, she bought a two-piece sofa and put them as an open L-shaped combination, allowing for a wider pathway to access the central

zone of the sitting room (figure 4.1). This caused a new issue as they needed to move the sofa set to a close L-shape for sitting closer as a circle around the coffee table when visitors came. Participant 1 said, “if we could find a better sized L-shaped settee to fit this wall, I will possibly change it".

Figure 4.2 Folded dining table from Participant 3

Moreover, participant 3 also pointed out that the limited sized living room made it difficult to select furniture to entertain visitors. As he lived in a flat by himself, the size of the living room was big enough for him to put furniture in for himself, but not friendly to entertain visitors. He mentioned that he needed to buy a foldable dinner table (Figure 4.2). with at least two chairs to host friends. Although the folding table might not be as steady as a normal dining table, he still needed it when a friend came over to have a meal together. Therefore, due to the size of the space, some participants felt limited in their ability to entertain friends in their living room, but they still wanted to invite friends to their home. How to maximize the use of space with furniture to allow for socialisation should thus be a key consideration when designing older people's living rooms.

The size of the living room also limited participants using adaptation products (such as wheelchair and walking support frame) in their living room now or should the need arise in the future. One participant had re-designed their living room to overcome this problem. Participant

Figure 4.3 Wider living room doorway from Participant 7

7 and her husband, both of whom used wheelchairs at home, had re-structured their living room and changed to a wider living room doorway to allow for easier access with wheelchairs (Figure 4.3). But, this solution is only suitable for those who had a larger sized living room to re-design. For smaller sized living spaces, it still posed a problem. This led some participants to worry that the size of the living room could limit accessibility for them to use adaptation products in the future: “I’m a bit worried about if some day my husband needed a walk support indoors...", Participant 9 mentioned.

Structure of the living room and effect on furniture layout

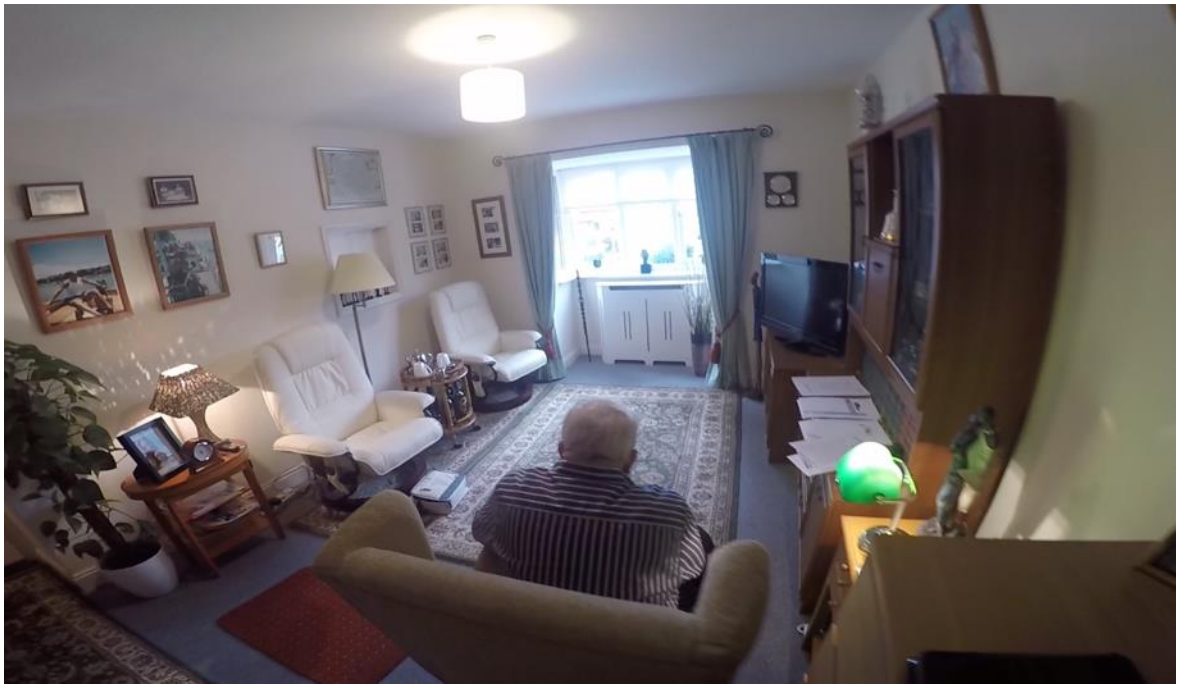

Figure 4.4 Participant 3's living room

The structure of the living room limited how older people positioned their furniture. As a consequence, some furniture was positioned in an inappropriate place to satisfy older people's accessibility needs. For instance, participant 3, lived in a flat with a rectangular living room. Most of his furniture was placed along the wall; two armchairs (for visitors), a small side table, cocktail cabinet, cabinet with five drawers and plants. In order to sit in a place that provides easier access to all furniture, he put his armchair almost in the middle of his living room. (Figure 4.4) Due to the narrow width of the living room, his armchair blocked the cabinet drawers, restricting access to open them (Figure 4.5). He also mentioned that he was not

Figure 4.5 Participant 3's armchair blocked the cabinet drawers

Figure 4.6 Participant 3's concave-shape of his balcony in the living room

satisfied with the concave-shape of his balcony in the living room: "If no walls there, I could have two cabinets to store my books and folders" (Figure 4.6). As there was no space to put a bookshelf in his living room, he had to move the bookshelf to his bedroom, which resulted in a complex process to access the books from his reading chair (in the living room) to the bookshelf (in the bedroom).

In addition, poor access due to the shape of the living room also showed from Participant 4 who had a closed small-rectangular space near the window in her living room. As she would like her furniture to all be allocated near the wall, she put a low-wood-cabinet in that area beside the window. That cabinet provided storage for her grandson's toys, but it blocked the way for her watering the plants on the windowsill, and also blocked her way of opening and closing the window (Figure 4.7). Therefore, the irregular shape (such as window bay) and narrow sized living room might cause poor access for elderly people to put their furniture to use.

Figure 4.7 Participant 4's low-wood-cabinet block the way to open and close the windows.

The location of the living room and effect on route usage

The shape and structure of the living room impacts on the route taken by participants to walk through their home (such as the route from the kitchen or hallway to the living room). For instance, participant 1 and Participant 2 lived in L-shaped living rooms. Both of them had closed kitchens, but the kitchen door linked with their living room (Figure 4.8)

Figure 4.8 Participant 2's L-shaped living room

Figure 4.9 Participant 1's living groom route, from kitchen to armchair

Consequently, they put their dining table outside the kitchen for convenient access to serve food. However, participant 1 pointed out that, sometimes, her husband and she would like to watch TV during eating. In this case they moved to their armchair to eat, which was further from the kitchen, in another corner of the living room (Figure 4.9). Participant 1 felt that it was easy to carry cold food from the kitchen to sofa area, but for hot food she felt it was harder to carry with a tray, as her hand could not hold a tray with much stability. Due to the L-shaped space and location of the kitchen to their living room, they have to put the dining table outside the kitchen as a dining zone for easy access to serve food from the kitchen, but this arrangement did not fit the participant's entertaining needs. Therefore, the location of the living room in the home and shape of the living room influenced how the elderly served food from the kitchen to the dining zone.

In contrast, participant 3 had a closed kitchen, not linked to his living room. He used to have a serving hatch between the kitchen and the living room, but he closed it and used it as a display wall to hang photos in the living room (Figure 4.10). He had problems with his leg as a result of a car accident a few years ago. When he prepared a meal in the kitchen, he had to walk out of the living room, and carry food from the kitchen to his armchair. However, when friends came, he needed to walk back and forth several times from the kitchen to the living room. During the research, he realised he might be able to re-open the serving hatch for easier access to serve food from the kitchen to the living room. Moreover, the location of the living room impacted on how elderly people designed their entertaining zone and how they walked through each zone easily and safely. For example, Participant 8, who lived in a house, said her husband and her spent most of their time in the living room downstairs for doing different activities.

Figure 4.10 Participant 3's serving hatch

She had a large sized living room and divided it into different function zones for her husband and herself. The sofa relaxing zone featured a 2-seat-settee and a 3-seat-settee arranged into a L-shaped sofa area. Beside the sofa, was her husband's reading zone, her jigsaw zone, and music zone (Figure 4.11). However, there were some access issues for her living room. The 3-seat-settee blocked the route for her husband from his reading chair to the bookshelf (only leaving a small gap to walk through). Her jigsaw table was put behind the sofa zone and in the front of the window, so it blocked their access to the window. Consequently, the location and structure of the living room had an impact on how the couple put their furniture to use in the living room. When designing the living room, it is important to consider how older people can easily access each function zone of the living room.

Figure 4.11 Participant 8's different function zones of the living room

4.2.2 Discussion

This user study observed the association between space, furniture and people in the living room using user study methods. Research findings showed that the space layout of the living room had an impact on how older people walk around in the living room and how the layout of the furniture fits older people's needs (or not). Previous research regarding space layout design has been discussed in terms of how to arrange furniture in a regular shape to meet human comfort (Mohammad et al, 2014), however, the arrangement of furniture in irregular shaped living

rooms was not discussed. From the user study, we can see that some participants had irregular shaped living rooms, such as having window bays in the living room. Furthermore, there is no academic literature on how to select small sized furniture for a small living room to meet older people's needs. Previous research mainly focused on furniture layout in the living room but did not consider the space size (Saruwono et al. 2012). From the user study, we found one participant had a very small sized living space that could not house regular-sized furniture and it may not allow them to use adaptation products (such as wheelchairs or walking frames) in the living room if required. Therefore, previous research has not considered the size of the living room and how it affects the ability to choose special sized furniture to meet older people's needs. Thus, the design insights for the size and structure of the living room are shown below:

- Small size furniture should be used for a narrow width living room to make sure older people have enough empty space to walk comfortably between the furniture.

- For wheelchair users, there should be wider pathway between each piece of furniture to make sure they can place their wheelchair in front or beside the furniture. The space should ensure the wheelchair can turn around without bumping

- For a smaller sized living room, folded or multi-functional furniture, such as a folded dining table, can be used for entertaining visitors. This furniture should be easy to move and light enough to carry from other room to the living room. Meanwhile, it needs to be easy to store.

- Consider how to let older people use a wheelchair or walking cane easily and flexibly in a small or narrow sized living room. If the structure of the living room could not change, consider designing smaller and flexible walking support products.

- Need to consider the position and flow of the living room in connection to the kitchen, as many older people eat in the living room and carrying food can be hazardous.

4.3 Floor and wall design of the living room

The floor and wall design of the living room had an impact on the ability of older people to safely access and do daily activities. In the user study, ten participants had carpet flooring and one participant had a wooden floor. Most of the participants used rugs/mats in the living room.

They had several reasons for using the rugs, such as to show division between different function areas, or to cover the carpets for hygiene reasons, or to protect the carpet colour from sunlight. The findings show that the floor design was directly relevant to the safety issues of the participants, particularly how older people 1) walked around in the living room, 2) moved furniture in the living room, 3) cleaned the living room, and 4) negotiated uneven floors. Moreover, findings of wall design included 1) the colour of the wall and 2) wall decoration in the living room.

4.3.1 Findings

Walking around in the living room

Firstly, the floor design influenced how the elderly walked around their living room. Some participants had flat carpets, which allowed them to walk around the living room without tripping. However, a few participants mentioned that their carpets were not flat and had been a trip hazard (such as rippling or buckling areas). Participant 3's living room had an area of wrinkled flooring (Figure 4.12). As he had a problem with lifting his left leg, he experienced difficulties lifting his leg high enough to avoid the uneven flooring.. The wrinkled floor had tripped him several times before and he realized that it was a potential hazard for causing falls.

Figure 4.12 Participant 3's wrinkled floor

Figure 4.13 rugs on the floor may cause tripping issues

In addition, he felt that it interrupted the aesthetic of his floor, but he felt it was too complicated to fix this problem as he needed to move his furniture away from the living room. The furniture was very heavy to carry out and he had no place to put it. As an alternative, he put two large rugs down to cover the wrinkled points (figure 4.13). However, this caused new issues. The rugs were not stable on the top of the carpet even though they had a non-slip mat liner. He mentioned that "my daughter bought some non-slip rug stopper to remain them in place, but it doesn't work". Participant 5 also felt that her rug was unsafe for her, she said that "I would move the rug (that) I have in the room as it could trip me up as I get older and not so steady on my feet".

Moving furniture

The floor design influenced how the participants moved the furniture in the living room. For the user study, five participants mentioned that a carpet floor made it easier to slide their furniture (such as settee, coffee table, side table) across the floor for different uses (such as to move the chair from open L-shaped settee to close L-shaped settee; move out the side table when friends come to put coffee cup; move the arm chair for a wider space to open the cabinet door, etc). However, several participants pointed out that due to their curled corners, rugs made it difficult to move the furniture.

Cleaning

Uneven and un-flat carpets and rugs might cause potential risks when older people are cleaning and vacuuming the floor of the living room. Some participants indicated that the unstable and curled corner rugs of the living room caused poor access when they were doing home cleaning, such as vacuuming the carpet. Moreover, during video observation, when participant 6 vacuumed the floor with a vacuum cleaner, she had to bend her body down to the floor to move the mat, which may make her lose her balance and fall on the floor (Figure 4.14)

Figure 4.14 Participant 6 needs to move mats to clean the floor

Colour of the wall and effect on brightness and size perception of the living room

Firstly, the wall colour of the living room had an impact on how the elderly felt about their living room in terms of brightness and size. In the user study, three of the participants mentioned that they had changed to a whiter, more creamy or lighter wall, which “gave (gives) an idea of space” (Participant 1) and let them feel more comfortable in doing their daily activities such as reading. Because their vision had reduced with age, they needed to live in a brighter environment. However, as they got older, it was hard to change the wall colour by themselves. Two participants indicated their desire to change to a brighter wall colour but “would (will) not be able to change it as they (I) get older” and as their son/daughter lived far away from them, nobody could help them to do this work.

Figure 4.15 a mirror on participant 4‘s living room wall

Figure 4.16 Participant 8’s living room with decretive items

Wall decoration

Secondly, the items on the wall influenced the perception of the size of the living room. For example, for a small sized living room, putting a mirror on the wall could make the space feel larger. Participant 4 pointed out that a mirror on the wall could make the room appear spacious (Figure 4.15), but if too many decorative items were on the wall, it could make the space feel crowded and messy. For example, participant 8 (Figure 4.16) and participant 11 (Figure 4.17) had large sized living rooms. The walls were filled with photos, paintings, and mementos, because it could let them remember a person or a special event and that made them feel happy and not lonely. However, it made the room darker and they needed artificial light during the daytime. Participant 5 had a smaller living room and she only had a large painted picture on wall, she said, “Minimalism could give an idea of space and brightness” (Figure 4.18).

Figure 4.17 Participant 11’s crowded living room

Figure 4.18 Participant 5’s minimalism living room

4.3.2 Discussion

Regarding the floor design of the living room, previous research mainly focused on confirming and observing the floor design in the kitchen (Wills et al, 2013) and the bathroom (Demirkan and Olguntürk, 2014). They suggested that a clear floor surface could protect older people from

falling. However, how to protect older people from falling and tripping in the living room has been less discussed. This is probably a consequence of the fact that living room flooring design does not present such a significant hazard as (slippery) kitchen and bathroom flooring. But through the user study, we found that most participants had rugs in the living room for decoration or other reasons, and that might cause tripping hazards for older people. In term of the wall design of the living room, the colour and decoration of the wall could impact on how older people feel about the size and brightness of the living room. Although older people would like to be hanging photos or collections on the wall, they still need to think about how to lay out the pictures and how to decorate the wall. Otherwise, it may make the room feel dark and crowded. Thus, insights of wall design of older people's living room are shown below: A whiter, creamier and lighter wall are more comfortable for older people's eyes, as their vision has reduced with age and they need to live in a brighter environment. Thus, insights for floor design of older people's living room are shown below:

- Consider designing a flat floor for older people. Rearrange furniture to create clear and wide floor space and remove unnecessary mats and rugs to prevent tripping and slipping accidents in the living room. Especially for older people who use mobility walking aid products, such as a walker or cane, uneven and un-flat floor might cause hazards. If older people want to use the mats or rugs for decoration reason, they should stick doubled sided tape onto the mats or rugs to make sure it doesn't move.

- Use a warm colour on the wall to promote a sense of security and harmony in the living room, such as soft yellow and soft orange. For smaller sized living rooms, a mirror can be fitted to the wall to make the space feel larger.

4.4 Door design of the living room

4.4.1 Findings

The issues with the living room doorway and handle

The door in the living room had an impact on how older people accessed the living room. Through the user study, the issues related to the door of the living room could be divided into three aspects, 1) whether the width of the door was easy to access, 2) whether the handle of the

door was easy to use, and 3) whether the open direction of the door was appropriate for the space.

In the user study, ten participants' doors were regular width. Only one participant extended her door to a wider one as her husband and her used a wheelchair at home.

Width of the door

The width of the door had an impact on how easily older people could access rooms, especially when using wheelchairs or walking support frames. Findings reveal that due to mobility issues, some participants had a reduced ability to negotiate the living room doors when they were using a walking frame, walking aids and wheelchairs. Facing this issue, one participant from the user study had made the home adaptation to extend her living room door for an easier wheelchair access. However, for those using wheelchairs or walking frames for a short time (for example recovery after an operation), they could not change the home structures, so it was a problem for them. The width of their door was designed as a normal width but did not allow them easily to pass through with the walking frame. For instance, participant 5 had a foot operation during the user study and needed to use a walking frame during her recovery. She complained how she experienced difficulty with the frame to pass the doorway of the living room. As the size of the frame was a bit large, she needed to twist the frame to go through. She said she could easily lose her balance. As a consequence, figuring out how to easily access the living room doorway with walking frame or wheelchair for short-time usage among old people needs consideration (perhaps a new walking frame design).

It was also found that the regular width of the door was not suitable for older people when they moved furniture from other rooms to the living room, or when they needed to temporarily use a wheelchair at home. Approved Document M (2014) highlighted the standard door width for wheelchair users moving between each room. This standard is useful for those who use a wheelchair at home for a long time and they may widen the doorframe to make it easy access. However, this study found that when older people required a wheelchair or walking frame for temporary usage, such as after an operation, the standard door width was not wide enough for them to go through and they had no reason to waste money on extending the door. Thus, in this situation, potential bumping and falling hazards present themselves. Therefore, it is not enough to design a smaller wheelchair or walking frame in isolation, but rather, there needs to be a

consideration of how older people interact with the living space, such as to pass a standard door width.

Handle of the door

In addition, the handle design of the door can cause poor access issues. In the user study, nine participants used lever door handles and two used knob door handles. The lever door handle users said they found it easy to open the door. The knob door handle users found it less user-friendly (figure 4.19). For instance, participant 5 complained about the round handle of her living room door. Her living room is located at the end of the hallway of the home. To keep the living room warm during winter, she always closed the door of the living room. The handle of the door is a knob, so she mentioned that it was hard to open with a wet hand or when she was carrying dishes from the kitchen to living room.

figure 4.19 knob door handle is not easy to grab, and the open direction of the door make room feel smaller

Open direction of the door

Moreover, the opening direction of the door influenced participants' perspective of the space and how they opened or closed the door of the living room. Findings reveal that some participants thought the door of the living room was useless. Participant 1 mentioned that she never closed her living room door because she wanted to have better air circulation, a brighter

hallway, and the perception of a larger living room. But she thought she still needed to have a door to allow her to feel like she was staying in a closed space even though she never closed it at all. Participant 3 mentioned the intention of taking off the door for a wider access pathway. As participant 1 and 3's living room doors are in the corner of the living room, the hinges were on the side of the wall, so they could open the door flush against the wall. However, participant 5 had an opposite swing of the door so that her wall was on the left-hand, and the door opened to the right. During the observation, participant 5 realized the issue of her living room door, which blocked the way for her to walk into the living room. Moreover, if she opened the door, as the door was not against the wall it made her living room even smaller. During the middle of the user study, she changed the swing direction of her door, and felt very satisfied with the new opening direction (Figure 4.20).

Figure 4.20 New open direction of participant 5's living room door (compare with figure 4.19)

4.4.2 Discussion

Previous research has confirmed that the door design in buildings should follow universal design principles to suit more people, including older people. Several suggestions have been mentioned from aspects of doorway widths (should be usable by more people), level door handles (easy to grip), and using door handles instead of doorknobs (King-Sears, 2009; Marquardt et al, 2011; Crews et al, 2006). Moreover, Ching and Binggeli (2017) described different door operation ways and highlighted the impact of the location of the door in the room. This should give a comfortable movement from one room to another, meanwhile being easily operational. From the user study, the author found that some participants had the intention of

removing the living room door for easier access and broader view when entering a room. Meanwhile, previous research suggested that the direction of the door swing should preserve the privacy of a personal space (Ching and Binggeli, 2017). From the user study, one participant's living room door swing direction had followed the design principle to preserve her living room privacy, but it blocked the view of the living room and limited furniture arrangement around the door. Therefore, how to balance the view issue whilst preserving privacy is a challenge. To conclude, the width of the door could impact on how easily older people can access rooms when using wheelchairs or walking support frames. Additionally, when selecting the handle of the door, older people's dexterity should be considered. Finally, the swing direction of the door influences how older people open and close the door and their feelings of space. Design insights of door design for older people's living room are shown below:

- Make sure the width of the living room door is wide enough to walk through with a wheelchair, a walker or cane (minimum 80cm). Extend the door frame if necessary. For those small sized living rooms that cannot extend their living room door width, the designer should consider designing a smaller sized wheelchair that can move easily inside.

- The opening direction of the door should lay flush against the wall to ensure there is a wider view from the hallway to the living room. Consider removing the door if necessary, to make a wider doorway. Meanwhile, the layout should consider the ventilation and energy problem. Removing the door will have better ventilation but will lose warm energy during winter. Alternately, consider installing a sliding living room door.

- Lever door handles are much easier to open than round doorknobs, especially for older people who have arthritis or reduced strength of hands. Lever handles are also easier to manage if older people are carrying something, as they can use their elbow to open the door.

4.5 Windows related problems

The window related problems were reflected from the aspects of 1) the size and position of the windows and 2) window access issues, such as window opening direction design, handle design of the window, and furniture around the window.

4.5.1 Findings

Size of the window and access to daylight

The size and amount of windows had an influence on whether older people had enough daylight and good temperature in the living room. All participants had at least one window in their living room, some of them had more than one, and some had a floor-to-ceiling window in their living room, such as a French door. Some participants indicated that they had adequately sized double-glazed windows and that this created enough sunshine during the day that could help save energy costs in the winter. However, participant 1 pointed out that this could create issues in the summer. Participant 1's window was very large and let lots of sunshine into the room. It made her feel stuffy. Therefore, she needed to close the blind to avoid the sunshine, but this also limited fresh air getting through and that made her very unsatisfied. Other participants indicated that although they love sunshine, strong sunshine through the window could damage the furniture and let the carpet lose its colour. They had some built-in blinds to solve this problem, but this resulted in other problems such as the blind being too heavy to roll, the blind being hard to clean, and a restricted view of the scenery outside.

Although the participants wanted daylight in the living room, daylight impacted on the way that participants laid out their furniture. Participant 1 mentioned that she felt lucky to have a large French door in her living room to have a good amount of sunlight during the daytime. Meanwhile, it let her husband see outside views through the windows. As she had a habit of reading when she was staying at home, she did not have the same need for scenery outside the window. Thus, she put her husband's chair beside the French door and put her chair next to her husband's. During the user study, she exchanged her chair location with her husband's in week 6 to gain more daylight to read. She told the author that her eyes felt more comfortable to sit beside the French door as the light come through the window and directly reflected on the paper she was reading. However, she exchanged her chair location back in week 7. The reason was that she preferred to sit in the familiar location, and she felt it could let her walk around more conveniently (as it was near the centre of the living room, near the dining table and kitchen).

She pointed out that although she preferred to read with the sunlight, considering her sitting location, she needed to use an additional reading lamp to support her reading. This highlights how changes in sight function influence the participant's requirements. Therefore, it is necessary to consider the size and amount of windows in the living room for older people. How to use the window for good sunlight and how to solve temperature issues in summer and winter is still problematic.

Position of the window- Sense of security

A few participants felt concerned about security due to large windows in the living room. Although they liked the ability of large windows to bring sunlight into the room, they felt vulnerable having such an open view to the outside world. They did not want pedestrians looking through the window and seeing a single woman living by herself, for example. Thus, some participants closed their curtains/blinds all day and lost their chance to see the outside scenery. Findings reveal that older participants highlighted a poorer sense of security when they stayed at home, especially for single women where their living room windows faced a public footpath. Although they needed more sunlight during the day, they still closed the blind to protect themselves and not allow others to know they lived by themselves. For example, participant 4 mentioned that "I would like a door screen, a security screen, as I have two sides of the flat covered by footpaths. I have a small Patio garden and the other side of the fence is a walkway for people so the security screen will give me privacy." (Figure 4.21) Moreover,

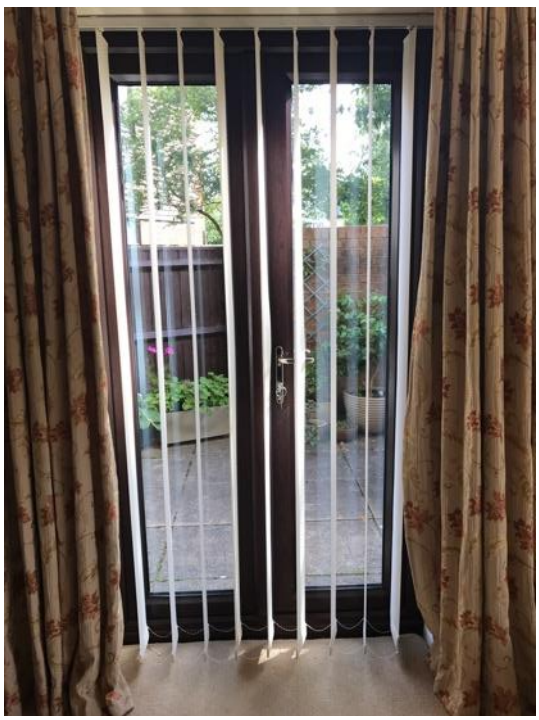

Figure 4.21 Participant 4's French Door with screen

Figure 4.22 Participant 11 closed curtains whole day to keep privacy

participant 11 lived in a bungalow and the window faced a public street. She didn't want other people to know that she lived in the house by herself, as she felt unsafe. Therefore, she closed the living room window and blind during the day to protect her privacy and help her feel safer (Figure 4.22). Thus, she had very bad daylight and air ventilation in her living room. In addition, a few participants pointed out that they worried about the bugs outside the window, therefore, they needed to close the window or curtains to avoid them. For example, participant 7 said that, "We do open one side of window but have to have curtain covering it because of spiders and flies could come in easily." (Figure 4.23). As the position of the window had an impact on older people's feeling of safety at home it can cause both privacy and safety issues. Therefore, when designing the house/flats for a single, older household, privacy and safety issues such as these should be considered. The direction of the window should face a non-public footpath. With a little innovation, the window could use special materials, such as using semi-transparent patterns or one-way mirror (which is a kind of glass that someone on the inside can look outside, but someone on the outside cannot look inside).

Figure 4.23 Participant 7's window blind

Access issues for windows

Access issues for windows in this study can be divided into two aspects. The first is the window design itself, which includes a) opening direction of the window, and b) position, height, and design style of the window handle. The second aspect was the furniture planning around the window that influenced the way older people access the window.

Access issue - Window opening direction

Depending on the window style in the living room, there were various ways to open and close the window. In the user study, most of the participants had casement windows, which attached to the frame by hinges at the side and opened using a casement stay. Two participants had tilt and turn windows, which can be opened like a casement window or can be tilted from the bottom. Two had Sliding French doors and one had casement French door. Due to the different style of the window, older people had different difficulties to open and close them. For example, participant 8 pointed out the issues of her casement window, which was a top-hung window and opened from the bottom out. She said sometimes it opened too far away (outwards) and she could not reach the handle of the window to close it. Thus, she had to go outside the house to push the window closed (figure 4.24). In terms of the sliding window, participant 1 pointed out that it was not easy for her to slide the French door as her hand muscle strength had diminished.

figure 4.24 Window issues of participants living room

Access issue- handle design of the window

Moreover, the window handle is another important design element that can affect older people's ability to open and close the window. From the user study, we found that more than a half of the participants had problems with their hands and fingers. Some of them had osteoarthritis and their finger joints had deformities, pain and swelling. As a consequence, it restricted the motion of participants' wrists and fingers. Participants also indicated that their hands had difficulties in grasping and pinching. These conditions make it harder for older people to grasp a handrail and open windows. Some participants highlighted that the window handle should be designed in a good position, at a reachable height and easy to grip, otherwise it can cause difficulties. In addition, the lock on the handle should fit older people's hand function, otherwise it can add challenges for them. For example, participant 5 said, "I would like to have no locks on window handles because as I get older, I may not be able to manage to lock and unlock."

Additionally, this study considered the need for electric windows and blinds among the participants as it could allow them to more easily open and close the window, especially for those using wheelchairs where it was particularly difficult to raise their body to reach the window handles. Previous studies have not considered how to design a reachable windowsill or handle for wheelchair users.

Figure 4.25 hard to access the window

Access issue- furniture around the window

Furniture planning had an impact on how older people access the windows in their living room. Due to the position of the windows in the living room, some participants had a clear space in

front of the window, however, several participants put some furniture in front of the window, thus blocking access. For instance, participant 11 (figure 4.25) had a long casement window

Figure 4.26 Sofa position made participant hardly access to window and blind

on the wall that occupied the space to otherwise put a storage shelf. Therefore, she put a long cabinet under the window to store her CDs and books. With her age increasing, she mentioned that it felt harder and harder to reach the window handle. Another example, due to the limited size of the living room of participant 5, she needed to put her sofa along the wall under the window. During the observation, when she closed the window, she needed to go down on her knees on the sofa (Figure 4.26). And she pointed out that in the future this might be a potential hazard for her as her knee had some problem bending. As these issues highlight, it should be considered how to plan the furniture in front of the window, especially for a living room limited in size.

4.5.2 Discussion

Due to the reduced sensitivity of light, older people need a good size and number of windows in order to have enough natural light to do daily home tasks and actives such as reading, take medicines, or watching tv, etc. Meanwhile, the older people also needed an appropriate arrangement of furniture (especially sofa or chairs) to gain enough natural light to read. Some participants confirmed the benefits of natural light. They pointed out that the natural light was an efficient light source, creating high level of illumination in the living room. However, although the older people needed a greater amount of natural light to see, their eyes were also sensitive to glare. Thus, they need opportunities to control the amount of light of the living

room to have to the most comfortable luminance level. For instance, participant 3 complained that in summer afternoons her living room had too much glare, so she needed to close the blinds to reduce the light to let her see things more clearly indoors. Hence, it was necessary to have blinds to control the amount of sunlight, especially for those who had large windows in their living room. In addition, older people also needed to use some additional lights when they felt that the natural light was inefficient. Meanwhile, these additional lights were also needed during the evening.

Studies in environmental psychology have assessed the relationship between the window and wellbeing of older people, revealing that a good view from the window scenery could provide a positive cognitive affect and produce a good mood (Pressly and Heesacker, 2001; Rowles et al, 2003). This could explain why participants prefer large sized windows in their living room. In addition, some researchers have investigated the relationship between natural lighting and windows location from an interior design perspective (Bokel, 2007), but there has been little focus on window handle design for older people. In terms of ergonomics of the product Pinto et al (2019) mentioned that older people need specially designed handles for easy grab. However, window handle design for older people has been less well observed. Literature also discussed the possibility of digital windows and curtains that could be implemented for older people. However, from the user study, we found that older people would like to keep their ability as much as possible. They preferred to open and close the windows and curtains by themselves and they considered that action as an exercise for their body to retain movement and flexibility. Some participants lived in their home for more than 30 years and their window handles were not as easy to operate anymore as they had reduced hand functions. Therefore, to design user-friendly window handles for older people using their existing window frames is necessary. Window design insights for older people's living room are shown below:

- Consider installing blinds on windows or French doors in the living rooms. The blind can avoid the strong sunshine that may damage furniture and carpet colour. The installed blind should not be too heavy and thick, and should be easy to open and to use. If an older person's window faces a public footpath, the blind also provides privacy.

- Avoid fitting top-hung windows that open from the bottom out, as it might open too far for older people to reach the handle of the window to close. Meanwhile, ensure the French door is easy to slide open, as older people's hand muscle was not strong enough to slide heavy French doors.

- Place the handles for windows at a suitable height to facilitate their easy use (recommended height 114-125cm from the door). The handle should be a lever design, to make sure older people can easy grasp and pinch.

- Make sure older people have a clear, empty space in front of the window to let them stand in front to open and close the window.

4.6 Sockets and switches of the living room

Switches and sockets are important for older people because they are in continual use. During the user study, the author found issues related to 1) socket position; 2) Hazards of adaptors (lack of sockets linked to hazards with adapters); and 3) Colour usage and design style of switches.

4.6.1 Findings

Sockets and switches position related issues

It was important for the sockets to be accessible as older people used them for many different items such as the TV and lamps. If the sockets were installed too high or too low this caused many problems for the older people as they are difficulty in kneeling and rising. Some participants pointed out that their sockets were too low to access. For instance, participant 8

Figure 4.27 Sockets are too low to access

said, “My wall sockets and sockets are all at floor level. I find it difficult to reach down for television and sky box as sockets are too low, as I grow older, I could not bend my body, this could be problem” (figure 4.27) Therefore, some participants pointed out that they wanted their

sockets positioned at waist height on the wall for easier access. For a short-term solution, a few participants used adaptors to solve this problem. For example, participant 9 said that, “Our sockets are situated in three corners of the room at floor level. We have adaptors to make them more accessible to use.”

From the user study, we also found that the amount of the sockets was not enough for older people to use in the living room. For example, participant 8 mentioned, “If I had this room done again, I would have them in different places, because sometimes you do need more sockets when hovering and charging phone and iPad. And when the grandchildren come and all want to socket in their devices, the sockets in my living room is not enough to use.”

Another problem related to the sockets and switches’ position was that they were often positioned behind the furniture, so they were hard to access. Due to limited range of motion of shoulder joint, two of the participants had reduced ability to reach distant objects and objects on the floor. For example, participant 6 indicated that the switches on the floor behind the TV were hard for her to reach. For safety reasons, she likes to close the main switch before she goes to bed or goes out, but the location of the switch was not within comfortable reach as she had the shoulder problems. She always asked her husband to do that. But it was not easy for her husband either, as he was a tall man and had difficulty bending his body down to the low level (Figure 4.28). Sometimes he felt he might lose his body balance. Moreover, participant 8 also mentioned that, “We have lots of sockets all at floor height in the corner. Some are hidden

Figure 4.28 Hard to access stock behind television

behind the music-centre not so easy to reach. We manage it at the moment, but I am worried in the future we could not."

Potential hazards of adaptors

Although some participants used adapters to solve this problem, this caused other new issues; 1) the adaptors did not match the existing style of the living room. For example, one participant complained about the adapter and she said, "less wires and the wires are always black-white would blend in better". 2) the wires of the adaptors caused tripping issues. For example, participant 8 mentioned that "one drawback is that it is plugged in by the wall and the lead goes over the carpet area which has access to the window table and music centre, so have to be careful not to trip over it" (Figure 4.29). Thus, it is necessary to explore new design strategies for positioning sockets in the living room.

Figure 4.29 tripping issues of adaptors

Figure 4.30 Large rocker-type light switches were easier to control for older people

Colour usage and design style of switches

One participant indicated that he could not clearly see the switch on the wall with his reduced eyesight ability, especially in a dim environment. This is due to the low colour contrast between the wall and the switches (they were both white, without edges). Therefore, due to older people's reduction of colour perception and discrimination of colour, it is necessary to use high contrast colour to enhance safety and accessibility among older people in the living room.

Moreover, participant 3 indicated that the large rocker-type light switches were easier to control (Figure 4.30). He had problems wrapping his hand around objects, so it affects his ability to turn and manipulate sockets and switches. Sometimes he could use his elbow to switch on the light when his hands were full.

4.6.2 Discussion

Wall-mounted sockets and switches outlets have been required to be easily reachable since 1999, and listed in Approved Document Part M (UK building regulation). That asked that the height of socket and switches should allocate between 450mm to 1200mm away from the floor, and at least 300mm away from any corner of a room (Figure 4.31).

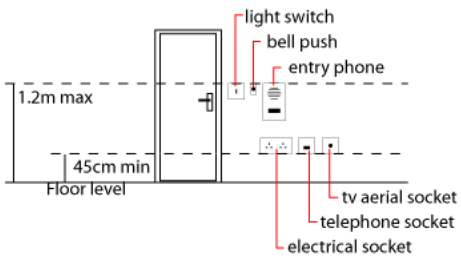

Figure 4.31 Socket and switch construction regulation for new homes (HM government, 2010)

However, houses or flats built before 1999 might not meet this requirement. Most of the participants had lived in their current homes for 30 years. Some of their houses were built before 1960s. From the user study, there were lots of issues related to wall-mounted sockets, such as the sockets are positioned in the corner of the room and were difficult for older people to access. Moreover, the issues cause by the use of additional adapters, such as the lead causing a trip hazards has not been given clear suggestions in this guide.

In addition, it has been confirmed that colour and contrast of wall-mounted switches is a significant factor for people with sight loss or dementia (Den Brinker et al, 2005; Kelly et al,

2011; Lawrence and Murray, 2009; Long, 1995). Studies indicate that switches with colour coding can help dementia and sight loss people to identify key features and rooms. However, in terms of most older people in the home environment, it is not necessary to add colour coding on switches as they are familiar with their rooms remember which switch links to which light. However, in terms of the shape and design style of the switches, literature from older people's reduced hand function perspective suggests that need big button surface for older people to operate (Phiriyapokanon, 2011).

Combining the findings and previous literature, design insights for socket and switches for older people's living room are shown below:

Ensure the number of sockets is enough for older people to use in the living room.

- Ensure the sockets are placed in an easily accessible location that avoids bending the body to reach them. AD Part M suggests placing the sockets between 45mmm to 1200mm from the floor, however, for older people, it is better to place the sockets from 600mm to 1200mm, as they might feel difficulty bending their body down. Meanwhile, avoid placing sockets behind furniture as this is hard to access.

- Avoid loose wires for adaptors that might cause tripping issues. If older people use an adaptor, make sure the wires are covered with tape to stick securely to the floor

- Ensure the colour of the switches on the wall has a high colour contrast and ensure the switches have a night light function that can be found easily in the evening. As older people’s vision reduces, it is necessary to use high contrast colour and night light to enhance safety and accessibility among older people to use switches and sockets in the living room.

4.7 Chapter conclusions

The existing literature emphasises the need to have a good understanding of space in order to create a functional home (Mohammad et al, 2014). However, there has been a lack research combining the living room space interior design with older people. This chapter responds to this gap in the knowledge by drawing on ethnographic insights to explore the space design needs of the ageing population. This section of the population has distinct and under-explored needs (which may overlap with but still be different to the needs of other disabled people). Even when individuals might not experience special needs now, with their age increasing, their current space design could create hazards for falling and tripping in the future.

Age-related changes of older people include sight function changes, hand function changes, body movement function changes, and psychological changes, This chapter highlights how the characteristics of ageing influence the ability of older people to use their living rooms most effectively. The chapter discusses the requirement of the living room design from 1) Size and structure of the living room , 2) Floor and wall design of the living room, 3) Door pathway and door design of the living room, 4) Windows of the living room, and 5) Sockets and switches of the living room. In each sub-section the author identifies potential design insights for how to design a safe and comfortable living room for older people.

Compared with existing research, the author found that there are still some areas that need further consideration. This includes a consideration of the size of the living room to choose special shaped or sized furniture to meet older people's needs, and how to balance the view aspect whilst preserving the privacy of the living room door. Building on these insights, the next chapter focuses on furniture relevant issues of the living room among old people.

Chapter 5 The requirement and design insights for living room objects to meet older people's age-related change

5.1 Introduction

The previous chapter explored space design in the living room. This chapter, chapter 5, presents and discusses findings related to furniture design in the living room. This includes lighting items, sofa, chair, table, and related life products and decorative items. The author not only explored the function of the furniture, but also investigated the interaction between furniture space and people. This chapter focuses on three research questions, which are:

1) What are the current forms of furniture design in older people's living rooms?

2) In what ways has the furniture design caused some issues and challenges for older people?

3) To what extent can furniture design meet older people's requirements and provide a suitable environment for them to stay in their homes.

The data collected from the ethnographic study includes in-depth interviews, cultural probes, and video observation. All data are transcribed into text version and analysed based on the conceptual framework below (Figure 5.1). Furniture related issues in the living room and older people's age-related change is discussed. Then some potential design insights are provided by focusing on opportunities for furniture and furniture arrangement design to meet older people's needs.

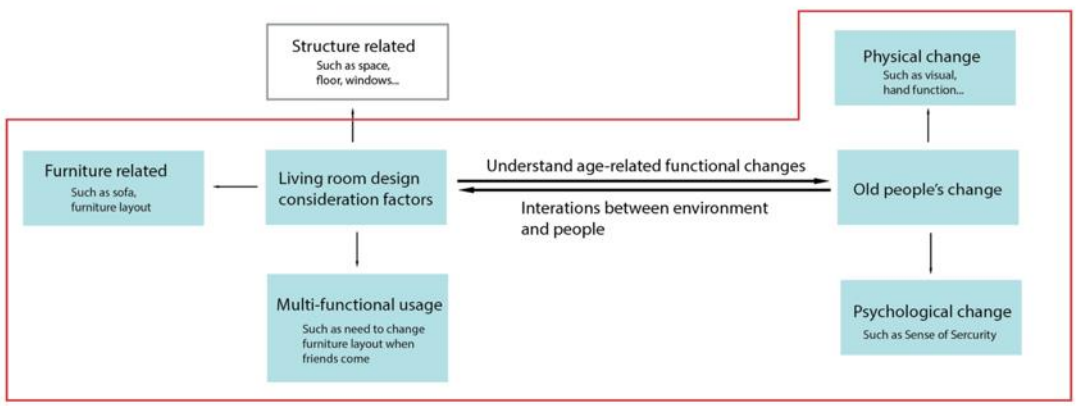

Figure 5.1 Focus on Chapter 5

The following sections will present the findings and discussions 1) lighting related issues, 2) furniture in the living room, and 3) furniture arrangement to meet older people's basic and multifunctional needs.

5.2 Lighting related issues

Lighting has an impact on the way older people carry on with daily activities (such as reading, sewing and crafts) as well as for safety in the living room. As sight fades when people age, good lighting is essential for older people, especially during the evening. The participants needed efficient lighting to illuminate the space, to support them as they walk through the living room safely and to do other activities during the night. For example, one participant said that effective lighting is particularly important for activities in the evening, such as knitting, sewing and reading. Several lighting related issues were discovered, and the following sub-sections summarise the key research findings from aspects of, 1) issues of the brightness level of ceiling illumination, 2) issues of the colour of ceiling illumination 3) issues of the colour of light, and 4) issues of the additional lighting facilities

5.2.1 Findings

Lighting issues; levels of illumination too weak

The levels of illumination brightness had an impact on how comfortable and safe the elderly felt in the living room. Due to older people's eyesight decline, their eyes are less sensitive to adjusting for brightness. From the user study, some participants were unsatisfied with their ceiling lights and pointed out that their ceiling lights were inefficient and inadequate to use. Several participants mentioned their ceiling lights were too weak and having one bulb only in the centre of the ceiling was insufficient. This caused hazards as the weakness of the ceiling lights did not let older people see clearly and created dark corners in the living room. Therefore, participant 3 pointed out that he wanted to replace the single bulb to multi-bulb lights to get more brightness in his living room.

Lighting issues; levels of illumination too bright

On the other hand, some participants mentioned that the wattage of the ceiling light was too high and hurt their eyes. As participant 5 said, "the main light in the middle of the room is too

harsh". During the user study, we found some participants had dimmer switches that could adjust the illumination level of the ceiling light in the living room. As participant 4 mentioned, "the ceiling lights are too bright for me. I do have a dimmer switch – when people come, some like the ceiling lights on" (Figure 5.2).

Figure 5.2 harsh ceiling light in the living room

After the observation, the participant told the author that she still preferred her table lamp as it softer, lower and subtler in effect. The dimmer switch only can change the level of the illumination but could not change the colour of light. Moreover, a few participants pointed out that the project lights and perimeter unit lights on the ceiling could be better than the central ceiling lights, as it diffused the light and made their eyes feel more comfortable to read or to watch TV. Participant 3 said that "replacing with perimeter unit lights around the living room will brighter, but its too expensive for me." Although older people knew how to change to a better ceiling light, considering the cost, they had to drop any plans to update their ceiling light. Due to the dissatisfaction of ceiling light illumination level, some of the participants did not use their ceiling light at all, as participant 5 said, "I have a centre light fitting but never use it" (Figure 5.3). Therefore, the design of the ceiling light needs to be considered when planning a living space for older people.

Figure 5.3 never used ceiling light

Older people needed more lighting in the evening due to their reduced sensitivity of light. The majority of the participants indicated that they had inefficient ceiling lights in the living room due to their low luminance level. They needed to use the additional lights (such as stand lamp or reading lamp) to support them to see clearly whilst doing specific tasks during the evening, such as reading a newspaper or doing jigsaws. In addition, participant 3 highlighted that it was important to avoid dark corners and low lighting levels in the living room, as it might cause trips and falls when older people moved around. This hazard happened during the period of the user study. Participant 8's husband had a serious fall in his living room at night-time. The reason was that her husband had a bad chest infection and could not lie in the bed to sleep. Therefore, he went to the living room downstairs and slept on his sofa. He had a self-raising sofa with a leg stool that allowed him having a comfortable position for sleeping. However, when he stood up to go to the toilet, due to the darkness, he could not find his balance to stand steady. Then he fell down and injured his head on the fireplace. Therefore, it is necessary to consider the elderly's unique lifestyle needs when designing the lighting system of the living room, as this example shows that the living room is multifunctional and, in this case, used as a substitute for the bedroom. To reduce falls and injury hazards there should be nightlights to allow older people to see clearly in order to maintain a good body balance when standing up from sofa or chairs, At the same time, the nightlights should not be too bright, as this can disturb their sleep.

Lighting issues- colour of light

The colour of the light could impact on how older people use their lighting facilities in the living room. From the user study, we found that the illumination colour was another reason that caused older people's challenges related to their ceiling light, as the traditional bulb could not change colour to fit older people's diverse needs when doing different activities. For example, participant 2 pointed out that her ceiling light was too warm. She felt it made it harder to focus on doing some specific activities, such as reading newspapers, and she felt a bit soporific with the warm light. Another example, Participant 11 had a cooler-bright ceiling light that she always used when she was reading, writing and knitting. However, she felt that when she was watching TV, she would like to have a warmer and softer light to give her a peaceful and more relaxing feeling. Therefore, depending on what activities older people did, they needed to shift between warm and cold light. The single-colour limitation of ceiling light could

not fit older people's need. Consequently, the multiple light sources (such as adding one table lamp) is more effective to support older people to do different activities in the living room.

Lighting issues- risks of additional lighting

Moreover, due to the different requirements of the illumination colour, additional lighting could give older people more options to select which colour of light they prefer to use in the living room. Participant 4 said, "I prefer the lamp on a cupboard by the side of the sofa where I sit. When I am on my own, I like the side warm lamp on". Additional lighting could solve the issues created by the ceiling light, but have new problems and potential risks for older people to use, such as

1) The switches of additional lights were not always easy to reach (e.g. the lead was too long and lamp switch was at the back of the table) (Figure 5.4)

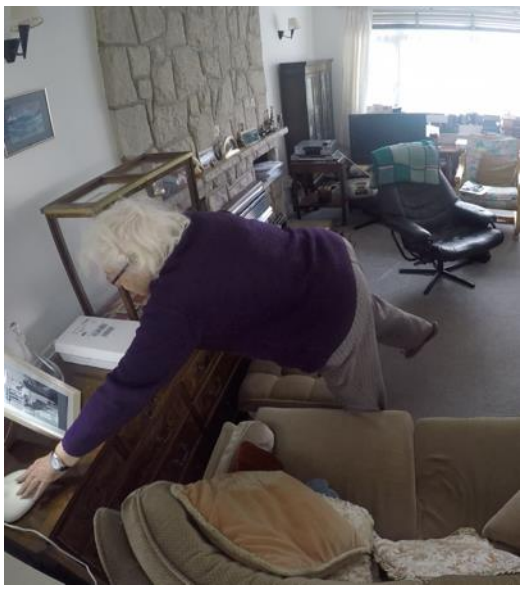

Figure 5.4 Hard to access switches of additional lights

2) The weaker lamps, whilst good for some activities, might cause bumping and fall issues (e.g. Participant 2 only opened her reading lamp to read in the evening, but when she stood up from her sofa and walked to the kitchen, her eyes were blurred and it was hard to transfer from a strong-reading lamp to a dark space) (Figure 5.5),

3) The distance between the switches for additional lights and ceiling light might cause fall issues (e.g. when older people shut down one light, they had to walk in a dark environment to open another light in the evening),

Figure 5.5 focus lights in the living room

4) The extension cords of lamps could be dangerous underfoot for older people.

Moreover, participant 8 pointed out that she expected to have a built-in light on the floor level of the wall, to let her walk-through safely without a ceiling and additional light on. However, she felt this was a bit expensive to install. Alternatively, she had a few battery motion-sensor lights in her living room. As it is a battery light, they needed to change the battery every week to make sure it worked (figure 5.6). She said that her husband always forgot to change the battery. It was better to socket it in, but the wire was either too long or too short to put the light in the right place. Therefore, the lighting issues should be a consideration when designing a living room for older people.

Figure 5.6 battery motion-sensor lights in her living room

5.2.2 Discussion

Previous literature has confirmed that the lighting design has an impact on people's physical, emotional, and psychological awareness (Kurtich and Eakin, 1993), and also influences people's perception of the quality of a space (Pressly and Heesacker, 2001). As people age, having proper lighting at home is an important requirement to support older people to do daily activities comfortably and safely. From the user study, the author found various lighting related issues that were either caused by natural light or artificial light. Issues related to natural light have already been discussed in chapter 4 that is mainly regarding the window location and size. In this chapter, the focus is on the artificial light in the living room. American Optometric Association (2006) had divided the artificial light into three main categories, they are; ambient light (supporting people to walk around and identify objects, such as a ceiling light), task light (supporting people to do specific tasks such as reading and writing, such as reading lights and standing lights), and accent light (highlighting displayed objects and architectural features, such as decoration or atmosphere light). Literature from interior design perspectives have experimented in using artificial light in an environment for supporting daily activities and decorating schemes in different function rooms, such bathroom and kitchen (Crews and Zavotka, 2006). Literature from age-related changes perspective have discussed the importance of lighting for older people as they have reduced visual ability, and it had been suggested that the lighting should not produce glare and there should be smooth transitions between light and dark (Agrawal, 2017). Considering that older people spend lots of time in the living room from day to night doing various multi-tasks, such as reading and sewing, some studies explain how to use light to support such specific activities (reading and sewing) (American Optometric Association, 2006). However, from the user study, data revealed that participants are still not satisfied with their light design. Some of the participants report the illumination level was either too strong or too weak. Other participants complained the colour scheme of the light was too cold. Therefore, the illumination level of light and light colour scheme should be further discussed to meet older people's needs.

Crews and Zavotka (2006) confirmed that older people need up to four times higher illumination level than young people. In addition, Knez and Kers (2000) found that the bluish ('cool') white lighting could make older people feel more peaceful. However, some participants complained that they did not like the cool and bright light but preferred warmer and dimmer ones. One reason for that might be because the user study was conducted during

the winter; the warmer light could let them feel warmer and match with the seasons. Another reason might depend on which activities they did. They also have different requirements with the light scheme between individual use and use with others. We found that an individual would like to stay in a smaller space with warmer and dimmer lighting. When friends came, or participants interacted with other members in the living room, they would like a larger space with cooler and brighter lighting. Therefore, the lighting design in the living room of older people should not only follow the interior design principles to set up the ambient light, task light and accent light, but also needs to consider when to use the space, who are going to use it, and to do what activities. Some lighting design insights for older people's living room are shown below:

- Install extra lighting in dark areas in the living room. Ensure the extension leads of lamps are not dangerous underfoot for older people. Avoiding long, loose leads will greatly reduce the chance of accidents. Meanwhile, installing an automatic night-light is a good idea in the evening.

- Replace the single bulb to multi-bulb lights to get more brightness in the living room as older people are less sensitive to adjusting for brightness. Meanwhile, install dimmer switches that can adjust the illumination level of the ceiling light in the living room. Avoid high wattage bulbs that hurt older people's eyes.

- For older people reading in a chair or doing craft projects, make sure the reading lights and controls are easy to reach.

5.3 Furniture selected in the living room

From the user study, we found that the declined movement ability could have an ultimate impact on how participants engaged in daily activities in the living room, such as difficulties accessing high or low furniture, of easily standing up from chairs, or of finding a comfortable posture on chairs. In this section, the author will discuss the challenges and demands of the facilities in the living room including 1) sitting facilities, 2) tables, 3) cabinet, 4) button design, and 5) radiator surface

5.3.1 Findings

5.3.1.1 Sitting facilities

Based on the observation and interviews, most of the participants have their favourite sitting areas in their living room. Those areas were designed and created by themselves and often not shared with anyone else, even their spouses. As older people spend more time in the living room everyday than younger groups, the sitting facilities are one of the most important pieces of furniture. Participants mentioned that the chair or sofa must be comfortable and have proper support for their arms and head. Based on the research findings, five key requirements for sitting facilities have been identified. Older people need 1) a suitable size to sit, 2) a good firmness and highness to sit ,3) a suitable height to sit and have an armrest to let them easily get up from the chair or sofa, 4) multifunctional seating area to meet different requires (such as massage, sleep or easy to move), and 5) good quality materials to maintain the chair or sofa.

Figure 5.7 Different size requirements of the armchair

Need suitable size to sit

Figure 5.8 Put cushions behind participant to make sofa less deep.

Regarding the size requirement, older people need different sized sofas to fit their body size. From the user study, we found that a few participants selected different sized sofas based on their height, for example tall participants required deeper seating than shorter participants. Participant 1 and 9 are shorter than average height of the participants, thus, they had narrower and shallower chairs in their living room (Figure 5.7). Meanwhile, as they had some knee problems, they indicated that a narrower and shallower chair could let them more easily rise out from their chairs. Furthermore, a few participants pointed out that their sofa was large and deep and they complained that when they sat on the sofa, their feet could not stay firmly on the floor. For example, participants 3 and 8 mentioned that a large and deep sofa was not good for short people. As their sofa had depth issues, they needed to put cushions behind them to make the sofa less deep (Figure 5.8) or need to put a step under feet (Figure 5.9). However, they still felt that the sofa was quite deep for them and their head and neck could not touch the back of the sofa. This could cause backache if they sat for over 30 minutes.

Figure 5.9 Put a step under feet

Moreover, participants' choice of sofa was limited by the space of the living room, for instance, some participants could not put a larger sofa in their living room due to the living room space and shape. For example, participant 7's husband is very tall with long legs, and their living room only can fit a regular sized sofa for his husband. From the observation, we found that the regular sized sofa was too small and too low for him. Her husband experienced difficulty standing up, as the sofa was too low (figure 5.10). Therefore, when designing older people's furniture, how to combine the product with the limited space still needs to improve.

Figure 5.10 sofa issues

Need good firmness and highness to siting terms of the firmness of the sofa, several participants reported that their sofa was sagging and too soft, causing them to sink into it. They felt backache after sitting for a long time. Therefore, some participants emphasized that they wanted to get a firmer seat sofa to support their back. For instance, participant 4 mentioned that a firmer sofa could better support his body movements, such as twisting his body to grab a book or a cup of tea on the side table.

Figure 5.11 Need a firm armrest to stand up

Moreover, many participants mentioned that they wanted to have a higher seated position as they felt it was easier for them to get in and out of the chair with this higher sitting positioning. However, the higher sitting position might not have a comfortable sitting experience. For example, participant 3 had a higher armchair. Because he had an operation with the left knees and ankles removed, his left leg was shorter than the right one and had less ability to bend. The higher armchair helped him to get in and out of the chair easily, however, when he sat for reading and watching TV, he needed to put a footstool under his left leg for comfort (Figure 5.11). During the video observation, this short-term footstool and armchair combination made him felt comfortable but also caused some tripping issues. When he got out of the chair, the footstool could block his way to walk through. This could be a potential fall hazard for him. Therefore, some participants had a foot lift with their chair or sofa to put their feet on. For example, participant 9 mentioned that, "my husband has a higher one he is 6 ft. 4' tall, his sofa is a recliner one. So, if he wants to relax for TV, he reclined the seat and put up the foot lift. So, his feet and legs are up, which as you get older is important when relaxing." However, during the video observation, the author found the foot lift was difficult to pull back down when he was sitting, as it had a manual operation. Consequently, when her husband stood up to go to the toilet, the foot lift made it difficult to find a space to stand up. She pointed out that

the electric one could have a better performance to let the foot lift out and back. However, she mentioned that she was trying not to buy new furniture as they were getting older. One reason was that the new furniture was too expensive, and she felt she could not afford it. Another reason was that she felt that if the old sofa only had a little problem but is still usable, throwing it away was waste of money.

Need a suitable armrest

During the user study, the author found chairs for dining tables raised lots issues among participants. Although the dining chair should be comfortable for dinner, considering the aesthetic, several participants' dining table chairs were designed without arms so that they could be pushed under the tables to save more space. However, during the video observation, the author found that a few participants had challenges when they were getting out of the dining chairs without arms. As they had reduced strength of leg muscles, they needed to use their upper body to help them stand up from a sitting position (Figure 5.11). The reduced ability to transfer from one place to another is another movement issue among a few participants. For example, (figure 5.12) participant 7's husband used a wheelchair at home; he needed to transfer from his wheelchair to his massage chair sometimes. He mentioned that it was important to have enough space to let him turn his wheelchair in front of the massage chair. Meanwhile, he said that although the self-raising chair could help him for this easier movement, the arm of the chair was a bit low to support him to stand up. As he lost the physical strength of his leg, he needed to use his arm to stand up. Therefore, when designing a product or furniture for older

Figure 5.12 Transfer from wheelchair to sofa

people, we should consider their body movement function changes. The attachments should support their action of movement, such as a chair should have an adjustable and solid arm to change the height to a comfortable level when older people sit, meanwhile having a good height to support them to stand up and transfer from the chair to other places. This could allow their upper body to assist with the transfer of weight and reduce the reliance on the leg muscles.

Need easy to move

Findings from the user study reveal that participants were weak in seizing or grasping objects. Some of the participants' hands had become flaccid after a stroke and lost their hand strength but they were still required to move heavy furniture by themselves, which caused issues with their hands. For instance, some participants needed to keep moving their chairs and side tables when friends came to visit them. Especially for those having a small sized living room, they needed to keep the most important furniture for themselves to use to have maximum empty space to let them move around in the living room. They did not have enough space to allocate extra chairs and side tables for visitors.

Moreover a few participants pointed out that it was better to have wheels under the chair to let them change the sitting locations in the living room easily. For example, participant 1 changed her sitting position with her husband during the user study, as she wanted to sit beside the window with more sunlight to read. Both of them were almost 90 years old and nobody helped them to move the furniture. She felt that this was made easier by having wheels under the chair.

However, other participants pointed out that wheels were unstable and could damage the carpets. One participant mentioned that she put plastic caster cups under the wheels to solve this problem. "I have plastic caster cups under the wheels, and if I move the sofa, they come out of the cups, so my daughter comes around to the flat at least once a month to put them back on for me."

As a consequence, older people's hands do not allow them to carry heavy chairs. It could be better to have wheels under the chair to let them move easily or to have a lighter but solid chair. However, a chair design with wheels did not satisfy all of the participants. They pointed out that some wheels kept moving around and were not safe for them to sit on. Some solid wheels were also too hard on their floor, both for wooden floor and carpets. Therefore, considering the function of the chair or sofa, the product needs to fit older people's needs (be easy to move),

meanwhile, the furniture design should think about the interaction with the space (such as floor), so as not to damage the floor.

Need support for sitting posture

Figure 5.13 Different sitting posture on sofa

Findings indicated that some participants had reduced ability to fit comfortably in their sofa or chair in the living room due to the reduction in muscle function. Participants had different postures on sofa or chairs (figure 5.13). Some participants had reduced muscle strength and thus could not keep a good posture when sitting. They needed to have an adjustable functional chair to fit their sitting posture, especially when they slept on the chair. For example, participant 1 mentioned that sometimes she had to sleep on her armchair, “in the afternoon. I was a bit tired and went to sleep about 40 mins (laugh). I can sit back and go to sleep here.” During the observation, the author found that when the participant easily fell asleep, their body leaned on one side or slouched down. This bad sitting posture might cause health issues, such as backache. For example, participant 5 slept for a few minutes on her sofa, but she did not notice it happened, until we reviewed the video. Participant 7 pointed out that her sofa did not support her with a

Figure 5.14 sleeping on sofa

good posture to sit and sleep. Especially, when she got chest infections, a poor sitting posture made her feel more uncomfortable sitting on the sofa when her body slouched down (Figure 5.14). Therefore, some participants indicated that it was better to have a recliner to raise their legs for resting and a full back and headrest to support them to have a good posture when they were sitting and sleeping. One participant mentioned that the recliners were very useful, and she even slept on the recliner during the evening, as she had some breathing problems to lie

Figure 5.15 elevated leg with better circulation

down in the bed. Another participant indicated that her leg had better circulation when seated on the recliner as her leg was elevated (Figure 5.15). Moreover, they also felt that the recliner chair could give them a comfortable position to avoid any neck or shoulder strains. However, considering the size of the existing living room, not every household could have enough space to use recliner sofa appropriately. For example, participant 9 had a recliner sofa for her husband, but due to her limited living room space, when he reclined the sofa and put the foot lift out, there was no space to walk through. And they did not have space to put a side table beside the sofa so it was difficult for him to raise his body up to grab items on the coffee table. Therefore, when designing furniture, the product range should be flexible so it can fit into different sized and shaped spaces.

Need special functions for support

During the user study, the author found that some participants needed chairs with a raised up function to support them to sit and stand-up out of the chair. Lift chairs were good for participants who had mobility issues, such as difficulty getting in and out of a seated position. For example, two participants mentioned that they needed a chair or sofa with raising up functions to let them get out of the chair easily (Figure 5.16). For example, participant 7 and her husband used wheelchairs at home. They had two electronic raised up chairs. When they transferred from the wheelchair to the chairs, they pressed the button and let the chair raise up to let them sit easily and safely. However, she suggested that if the arm of the chair could be

Figure 5.16 Raising up chair help older people get out of sofa easily.

higher, her husband might find it easier to hold and transfer himself from the chair to the wheelchair.

However, a few participants indicated issues with their recliner lift chairs. As they had reduced leg muscle strength, they felt that it was hard to control their legs to close the footrest extension of a manual recliner lift chair. For instance, participant 9's husband preferred not to close the footrest extension during the sitting time, even when he wanted to stand up to go to the toilet. However, the footrest extension gave him nowhere to put his feet. He needed to put his feet on each side of the footrests, but that posture made it harder to use his leg muscle to stand up. Therefore, when designing the furniture for older people, every part and function should be easy to control with reduced strength of muscle. Moreover, her husband mentioned that he wanted the chair to be turned around as he wanted to have the opportunity to see around the living room. Therefore, the form of a chair with a solid arm and a turnaround seat were welcomed among participants. In addition, participant 3 pointed out that his massage chair was important for comfort and reduced pains.

Figure 5.17 Cloth on sofa to keep clean

Need good quality materials to maintain

Participants also discussed maintenance issues with their chairs or sofa. As their hand function reduced, sometimes they spilled tea or coffee on the sofa. Consequently, some participants put

a cloth on the top of the chair for easier cleaning (Figure 5.17). Therefore, choosing material that is easy to clean and waterproof were necessary for chair or sofa design for older people. Moreover, the colour of chair seats should have a high contrast with the floor colour to increase the visibility of the edge of the chair for older people and avoid fall hazards.

5.3.1.2 Table design for older people

Table related issues focused on the table furniture that is used by older people themselves, such as a coffee table, a side table, a chair table or a dinner table. Based on the observations and interviews, all the participants have more than one type of table in their living room and combine them to use in different circumstances. Based on the research findings, four key requirements for table furniture have been identified: 1) the need for a suitable sized table to fit the available space 2) need for a suitable height table to reach 3) need for safe table leg and surface.

Need suitable sized table to fit the space

Figure 5.18 Eating on sofa with tray

Depending on the space of the living room, participants chose a different size and style table to use. The size of the space had an impact on the table selections. From the user study, not

every participant had a coffee table or dinner table in the living room, as the size of the space was limited. For those small sized living rooms, participants found it more convenient to use a smaller table or side table instead of the coffee table. For those who did not have a dinner table, they ate on the sofa by using a tray (Figure 5.18). Without putting in a coffee table or dinner table they could have more space in the living room, however, eating on a tray was not suitable for all meals, especially, when friends came. One participant had a folded chair table that could be used when sitting on a chair or sofa. But he pointed out that the chair table is difficult to move on the carpet, unstable, and the top was a bit small and slippery (unstable to put a glass of wine on, for example). Therefore, the table selection was impacted by the available space in the living room. A small table is necessary for the small sized living room, but it needed to be as stable as the big and solid table.

Need suitable height table to reach

Participants also mentioned that the height of the table was important for them. They needed an appropriate height coffee table or dining table that allowed them to reach it easily. For the participants in wheelchairs, they pointed out that the dining table should have a proper height for wheelchair use with a wheelchair accessible model.

Need safe table legs and surface

Moreover, two participants complained that they had coffee table legs that curved outwards, and this was a tripping hazard for them. Meanwhile, one participant mentioned that he preferred a table with rounded edges, as it could prevent him from bumping into sharp corners. In addition, from the user study, we found that the surface of the table could cause hazards among older people. One participant mentioned that glass-top tables were easy to break, therefore she preferred a solid wood table to use in her living room.

5.3.1.3 Findings: Other furniture and facilities in the living room

Participants also indicated that they needed to use a ladder or step to reach a higher position in the living room. Because they had reduced ability to climb a ladder or step, it could cause fall issues. For instance, participant 1 pointed out that she needed to use a step to reach a high position to clean the window in the living room. Though the step was stable enough for her to stand on, it still had a potential fall hazard as she had difficulty controlling her leg to rise up. Moreover, another two participants mentioned that they used a ladder when they needed to re-

paint the living room wall by themselves as they wanted to change it to a warmer and brighter colour. The ladder was also a potential fall issue for them as they were getting older. Therefore, how to use other types of tools instead of climb ladder or step to help older people to reach high position needs consideration.

Storage furniture

Storage related issues could impact on how older people organized their stuff in order to have a living space free from clutter. It focuses on the storage furniture that lets older people manage their stuff, such as a bookcase, a drawer storage unit, a sideboard or a cabinet. Based on the research findings, five key requirements for storage and display have been identified among the participants: 1) the size and shape of the storage furniture needs to be suitable for the space 2) the height of the storage furniture needs to be easy access, 3) the handle of the storage furniture needs to be easy to use,

Findings from the user study show that the participants required storage space and they needed suitable sized and shaped furniture to fit with the living room structure. They needed to have as much storage furniture as they could, while keeping enough empty space to create a risk-free environment. One participant complained that a large, deep storage unit in his living room had caused some bumping issues. Therefore, he needed a smaller and shallower storage unit alongside the wall. Moreover, one participant mentioned that she was very satisfied with the triangle shaped shelf in the corner of the living room, as this shelf could fit into the shape of the living room and give her more storage space, meanwhile, giving her more empty space to walk around the living room. Therefore, when designing a living room, the designer should consider how to select a good sized and shaped storage furniture for the living room to fit with the structure of the living room space. Meanwhile, the designer also needs to think about the holistic environment and how older people interact with the space and furniture.

From the user study, we also found that the height of the storage furniture needed to be at an easy reach distance to make sure older people could use it safely and conveniently. For instance, participant 10 complained about her floor level storage drawer because she had some back issues and could not bend down. In addition, participant 8 mentioned that she put items she used on a daily basis within easy reach and avoided using tall shelves. When she needed to use the tall shelves, she always used a step stool. But the step stool was not stable. Attempting to

reach items in higher spaces could pose a fall risk for older people, especially for those using wheelchairs when it was difficult for them to reach high or low storage space.

Easy grasp of the furniture handles was one of the key requirements for the furniture design among older people. During the user study, some participants pointed out that cabinets with drawers that glide easily were good for them to use. These cabinet handles should be easy to grasp as hand functions reduced with age. For example, participant 9 had arthritis and mobility issues. She said, "it is important to make sure desk drawer handles can be gripped comfortably".

Button design for older people (devices)

Findings also reveal that when participants had reduced dexterity of their hands they found it hard to control small buttons on devices, such as the TV controller. For instance, participant 3 complained that the button on the TV controller was too small to see and too close together to let his fingers point to the correct one, even though he remembered which button was the correct one. Moreover, participant 6 also complained that the controller buttons on his digital self-raising chair were too small and hard to control. Therefore, facilities in older people's living rooms should have larger buttons to let them touch and control more easily. For example, due to a sight impairment, participant 11 had an enlarge-fonts reading machine in her living room. It only had a few large buttons to control. Though her hands were flexed, and joints deformed, she still found it easy to operate.

Radiator surface

The last issue regarding the hand function changes was to avoid having hot surfaces in the living room as older people have reduced ability to feel temperature on their hands. For instance, participant 6 mentioned that her hand was hurt by the radiator when she was doing cleaning in the living room, as the radiator surface was a bit hot in the winter, but she could not feel it that hot. She wrapped the duster on the radiator and her hand went red due to the heat. Therefore, the surface design of the radiator or other facilities (such as fireplace) in the living room should be considerate of older people's hands or legs.

Decoration elements

Older people have more requirements for decorative elements with the living room (such as usage of colour and lights, and decorative items being meaningful to them), as such items can give older people a positive mood to evoke their personal emotions.

Findings from the present study also show that the living room decoration elements (which could also be called atmosphere design) could influence older people's mood when they stay at home. The atmosphere design elements in this study include the usage of colour on wall, decorative lighting system and the decorative items of the living room. The use of colour on the wall and the decorative lighting system in the living room can create some special atmosphere. Several participants mentioned that they changed to a warmer wall colour recently for a comfortable psychological feeling and to give a positive effect on the mind and mood, as sometimes they might feel a bit lonely. Meanwhile, they felt the warm colour could promote security and harmony of the living room. Moreover, a decorative lighting system also let some participants feel a sense of comfort and pleasure. Come December, most of them said they had Christmas lighting to decorate their living room for a seasonal feeling. Some of them used candles and the fireplace to give them warmer feeling when they stayed in the living room over winter. Even for those who did not have a real fireplace, they installed a fireplace screen to evoke feelings of a cosy, rural life.. In addition, the decorative items in the living room were important and meaningful to older people. These decorative items include photographs, art displayed on the walls, knick-knacks, and books on display. We found that each participant had their own taste for colour schemes and certain types of objects to display. This gave them the sense of private space and something personally meaningful. For example, participant 3 mentioned that, "Flowers, plants are essential in bringing colour to what is otherwise a dark room".

Decorative items are thus an essential part of the living room for older people and evoke feelings of nostalgia. Participant 8 pointed out that, "the ornaments and photos are very important. They are a history of our life." Moreover, participant 3 mentioned "Flowers, plants are essential in bringing colour to what would otherwise be a dark room." During the user study, we found that some participants had been living in their home for years and they had more things filling their living room than they needed there. Some of them had a very cluttered space with lots of trip hazards. To ask them to rid of these items might be unrealistic, as participant 7 said that "my living room is the place to display objects with sentimental value." As a result, older people need to find a better way to display the items to decorate the space without hazards. For example, Participant 9 pointed out that "Little objects around shelves are nice if limited with space in between and are a memory of times gone by" and "Window sills give the same opportunity to display items" (participant 3). Moreover, participant 6 mentioned that, "Wall space is important in order to display photos etc which are an important memory of our lives".

Therefore, to hang photos on the wall was better than to put the photo frame on a table or shelf where it takes up more space. In addition, participant 8 complained that the books, magazines, and daily newspapers took up space and gave the room an untidy appearance. Therefore, she used a basket to store the newspapers and magazines. Every few months, she recycled or donated items that they had read. Moreover, this participant had lots of souvenirs, gifts, and photos on every surface in her living room, making the space cluttered. After the user study, she intended to install shelves to enable her to move these items off usable surfaces. Therefore, it was necessary to well organize the objects of the living room, to select and to display the most important objects to make the living space less cluttered, and thus have a safer environment for older people to live.

5.3.2 Discussion- Accessible and ergonomic furniture

The findings highlight various issues related to furniture selected in participants' living room, such as the sofa size and shape not fitting with the body, the table size not fitting with the space, the height of the unit furniture and cabinets being too high or too low, and so on. From the qualitative user study, we investigated the older people's needs and how these needs relate to furniture use. The results also show older people's preferences of the furniture design and revealed a diversity of requirements and wishes, such as the desire to eat on the sofa. Previous literature has indicated that older people have changed their eating behaviour in recent years/decades. Older people have moved from the dining table, the formal place for mealtimes, to the sofa, because they want to watch news. This is especially true for those living in a single household. Some older people do not even have a dining table at hom because they moved to a small sized flat therefore, they had no space to put a dining table. Eating on the sofa is a very popular phenomenon of ageing society. Thus, sofa design should consider older people's eating behaviour requirements.

Previous literature from a furniture design perspective has discussed how to design furniture to fit with customers' experience (Hrovatin et al, 2015). Jonsson (2013) suggested that it is necessary to use the user-centred design approach to understand older people's needs when designing a piece of furniture for older people. His research scope mainly focused on the chair design for older people, and he used a model to conceptualize the relationship between older people and furniture. The model argued that furniture design for older people should require aspects from fit usage, fit human body, suit the individual, and fit physical environment. This model could be used to confirm our research findings that, 1) The characteristics of different

types of furniture in the living room should fit older people's requirements, 2) the size, shape and height of the furniture should fit with older people's body size, 3) the furniture in the living room should allow older people to do their own hobbies, such as sewing and puzzles 4) the furniture design should fit with the space around it and match with the design style of the living room.

In addition, the requirements of multifunctional furniture and adjustable shaped/sized furniture were found through the user study. According to Lam and Thomas (2007), adjustable furniture can pack into a smaller piece, making it suitable for a smaller room. They confirmed that this could help make the space more adaptable for doing different activities. However, the design and quality of the adjustable furniture needs further evaluation, as a participant still complained he could not find a good quality, folding table to match his living room. Moreover, in terms of methods for observing older people's needs, Jonsson (2013) argued that through interviews we only get information from the participants with their existing knowledge of their body change. Therefore, ethnographic or video observation approach could overcome this limitation. From the user study, some furniture requirements were from the knowledge of the participants, based on their understanding of their body conditions and knowledge of what furniture was fit for purpose. Yet, some furniture requirements observed from the video observation revealed potential issues that participants had not yet realised. It also revealed that older people did not realise their body conditions had reduced their physical ability due to age. Some of them still had extremely positive attitudes to evaluate their existing furniture until the hazards had happened. As a consequence, older people need to update their information and need to gain knowledge of how to improve their living environment to allow them stay at home more comfortably and safely. Furthermore, furniture design for older people should consider the cost and give an affordable price for older people to buy it. Moreover, the government or health service could give some support to help and encourage older people to update their existing furniture, such as exchanging the old sofa to a new one, and only paying a little money. More design insights regarding sofa, table and other furniture in the living room for older people are listed below:

Sofa:

- When designing or selecting a sofa or armchair for older people, ensure the chair/sofa is a suitable size to sit to fit their body size. Ensure the chair/sofa has good firmness to sit and supports their sitting posture, including when eating on the sofa. Meanwhile, the

height of sofa/chair and the armrest of sofa/chair are important to allow older people to get up from sofa/chair safely.

- Multifunctional sofa/chair is necessary for older people. A useful feature is a foot-lift and raising up function. Ensure the foot-lift of the chair is easy to pull out and back to avoid use a footstool as it might cause tripping issues. Moreover, ensure the chair has a raising up function to let older people get out of the chair easily.

Table:

- Ensure dining chairs are designed with arms, as older people have reduced strength of leg muscles and they need to use their arms to support their body weight. Ensure the table legs and arms are steady and solid. Ensure the table surface is safe (no glass surface)

Other furniture in the living room

- Make sure storage space for furniture in the living room design is between 60cm from the floor and up to 140cm from the floor.
- Avoid using a ladder to reach high storage space.
- Provide mechanical remote-controlled devices if necessary, to reach high or low storage space.
- The characteristics of different types of furniture in the living room should fit older people's requirements.
- The size, shape and height of the furniture should fit with older people's body size.
- The furniture in the living room should allow older people to do their own hobbies, such as sewing and puzzles.
- The furniture design should fit with the space around it and match with the design style of the living room.
- Ensure accessible and ergonomic furniture is selected.
- Encourage the placing of plants and flowers inside the living room.

- Encourage a better way to display decorative items without causing hazards.
- Avoid a very cluttered space with lot of tripping hazards.
- Ensure to well organise the objects of the living room, to select and to display the most important objects to make the living space less cluttered.

5.4 Furniture arrangement

Furniture placement related issues focused on how older people layout their furniture in the living room. Based on the user study, two key requirements for furniture placement issues have been identified among the participants: 1) furniture placement needs to be comfortable, safe and allow easy navigation of the space, 2) furniture placement needs to welcome visitors, and 3) need to create multi-functional space for older people.

5.4.1 Findings

Comfortable, safe and easy to navigate the space

As we know, furniture placement was influenced by the shape and size of the living room. Though older people could not change the size of the living room, they required a safer and a more comfortable living room space to meet their aging needs. During the user study, it has been found that the living environment could be improved by rearranging the furniture. From the user study, it was observed that a few participants had a bad arrangement of furniture and that this could cause problems. For example, one participant's side table was too far from the side of the chair, so that she could not reach it and may strain as her body leaned over. However, moving the side table in front of the chair might avoid this hazard. Another example, due to shoulder issues, participant 6 pointed out that she had difficulty putting a cup on the coffee table from a seated position on the sofa. Instead, she used a tray to put cups beside her on the sofa for an easier reach. However, she indicated that it was not stable to hold a cup on a tray and sometimes it spilt water on the sofa.

The act of making furniture placement comfortable and safe in the living room could also create clutter-free space. Participant 3 mentioned that it was important to have clutter-free environment as clutter (such as books) could be downright dangerous (from a bookshelves) and cause falls. Therefore, participant 5 highlighted that keeping shelves orderly via using some storage boxes avoided objects slipping from shelves. Moreover, moving unused furniture

away could also improve the health and safety issues among older participants of the living room. From the user study, we found that unusable furniture occupied space in participants' living room, such as side table and extra chairs. Participant 7 mentioned that if they wanted to use a walking frame in the future, the coffee table might need to move away to make a comfortable and safe space. Therefore, the participant needed to move unused furniture away to have more empty space to stay. Participants also showed their requirement of having enough room to navigate in the living room, especially for wheelchair or walking frame users. For example, one participant used wheelchair in the living room. He mentioned that he needed more space to turn around and need a wider gap between furniture to let him pass easily.

From the user study, it has been found that although one participant had a high-quality wheelchair and a functional self-raising armchair, it was still difficult for him to transfer from the wheelchair to the armchair. Moreover, after the transfer action of the participant from the wheelchair to the armchair, where to put the wheelchair was another issue. It blocked the pathway for his wife, who had mobility issues as well. Therefore, when laying out the furniture, it needs to have extra physical space for wheelchair users turning and storing their wheelchair (Yu et al, 2011).

Welcome visitors

Participants also highlighted the need for socialization in their living room. The living room is often used to entertain visitors, allowing the older people to have a good social relationship and help protect against psychological distress by enhancing their well-being through socialisation. For example, participant 1 mentioned that " My husband is deaf, and I like company to chat to. I enjoy entertaining my friends and family. It doesn't bother or worry me- it makes me happy because I like company." Participant 9 also mentioned that they loved family around, plus when their son came to visit them, he could help them to do some work that they could not do, "What makes me happy is I love company especially when our son comes to visit every six weeks and he can help put up curtains, take light fittings down to be washed and put back, and odd little jobs we cannot do." Some participants had enough space to entertain visitors and had a large dinner table to allow visitors to eat. For example, "If we all eat together, I can extend my dining table and can sit eight people around it which makes me very happy" participant 1 said. However, other participants moved to small flats to live by themselves and did not have the opportunity to have visitors over for meals together. For example, participant 3 mentioned, "I planned my flat specifically for a single person which I now realise was a bad mistake. I

have many problems when socialising with family and friends. One major fault was on having sufficient seating and another no dining facility". The limitations of space made him feel isolated and depressed. Therefore, he had intended to buy a folding dining table and chairs for visitors but could not find a good one.

The requirements of furniture placement were not only for participants themselves, but also needed to welcome visitors. For the user study, we found that participants changed their living room furniture layout to entertain different types of visitors, such as families (children and grandchildren) and friends. Thus, they have different requirements to entertain different visitors. Moving furniture for temporary use was a very common phenomenon when participants entertained visitors. For instance, one participant mentioned that when friends came, she had to change the layout of the settee to let everyone seat closer as a circle for conversation. Moreover, participant 5 mentioned that sometimes she had to hold community meetings in her living room with more than ten visitors (figure 6.5). She moved extra chairs from the dining room to the living room to make sure that everyone had space to sit and be comfortable. However, if they needed to move the settee or side table, there were some potential hazards, such as 1) the furniture was too heavy to move and hurt their back or shoulder, 2) they felt difficulties to move dining chairs from another room to the living room as the pathway and doorway was too narrow, 3) the temporary layout of the side table or chairs might not have enough space to allow them walk through the gap and this could cause bumping issues. Moreover, some participants had multifunctional furniture to accommodate visitors, such as an extending dining table. For instance, participant 1 felt happy as she had an adjustable dining table to let all family eat together, she said that “If we all eat together I can extend my dining table and can sit eight people around it which makes me very happy”. Then, she complained that when she extended the dining table she had very little space available to walk around it. As a consequence, when selecting extendable furniture for older people, it needs to take consideration of each possible way to layout and use the furniture. Extending furniture from a smaller size to a larger size required more living room space to ensure a safe and convenient interaction. For those who had a smaller sized living room, they complained that they did not have a chance to use extendable furniture and have extra seating space for visitors. For instance, participant 6 considered that “due to lack of space it’s not easy to keep spare chairs and tables available. Quite often my grandchildren have to sit on the floor.” In addition, participant 3 complained that the single flat was unfriendly to invite friends over and had insufficient seating and he mentioned that if he could change the furniture arrangement of his living room, he

wanted to install a fold-up dining table and two chairs. Therefore, furniture arrangement should not only consider letting older people use the furniture themselves comfortably and safely, but also needs to consider the way they entertain friends and visitors.

Create multifunctional space

Moreover, participants also highlighted the needs of a multifunctional living room as they would like to use their living room at different times for either visitors or private behaviours. For example, participant 4 mentioned, "I am very happy when entertaining family and friends. It makes me happy if people come to visit. What make me happy, if my friend and family are happy. But sometimes, I do like being on my own." Her living room space allowed her to do different behaviours by adding a temporal dimension. When her grandchildren came, she moved out one cabinet as a dining table to let them play around. When she stayed by herself, she moved it away to have a large empty space for better movement. In addition, we found that some participants (mainly couples) divided their living room space into different function zones by the division of behaviour, which supported them to have a multifunctional living room for the same space. For example, participant 9 divided her living room into her husband reading zone, her jigsaw zone, music zone, and sitting zone. Under the same space, they could do private activities by their own, meanwhile, it allowed them to sit together to watch TV and chat.

5.4.2 Discussion

‘There’s no need to get rid of every piece of furniture; keep everything you need, but keep only those things, so your layout remains simple and efficient’ – AgingInPlace.org

The research findings show that the furniture arrangement had to consider the restricted space of the living room. Depending on the size of the living room, participants selected different types and sizes of furniture. Meanwhile, participants had to make a suitable furniture arrangement to support their daily lifestyles. Furniture arrangement guidelines have been discussed by various interior designers from theory to practice (Lyons 2008; Yu et al, 2011; Kubba, 2003; Pile 2007; Karlen 2009; Merrell, et al, 2011), who confirmed that the furniture arrangement should consider both functional criteria and visual criteria. In terms of the functional criteria, the furniture arrangement should follow human behaviour and enable comfortable conversations to be held,. In terms of the visual criteria, the furniture arrangement should have a good balance of visual composition of a space. This includes alignment of the furniture with the structure of the space and emphasis of key functional zones in the living

room (such as seating). Meanwhile, the living room furniture arrangement should plan to follow older people's daily cycles and have a consideration for different uses of the space across time, such as relaxation and comfort by individuals, and spending times with family (Saruwono et al, 2012). Thus, design insights related to the furniture arrangement are listed below:

- Ensure furniture is easily movable.
- Provide wheels under heavy furniture.
- Make sure the wheels are stable.
- Make sure the wheels designed do not damage the carpet.
- Ensure furniture placement is comfortable for use.
- Ensure furniture placement is safe.
- Ensure furniture placement can welcome visitors.
- Ensure the furniture is placed in an appropriate way to access sunlight.

5.5 Chapter conclusions

This chapter focuses on the age-related changes of older people through sight function changes, hand function changes, body movement function changes, and psychological changes, to observe the requirements of living room design for older people. It discusses the requirement of the living room lighting design, furniture, and furniture arrangement, and then, gives design insights for the living room for older people. Comparing and combining with previous research, this study has confirmed some of the requirements and consideration points of the living room design based on older people's physical changes (including sight, hand, body movement) and psychological changes (including sense of security, sense of identity and needs of social communications). The lighting system was important for older people as their visual ability reduced with age. Moreover, participants' experienced conflict in choosing furniture that meets both functional and aesthetic requirements. In addition, the arrangement of the furniture also needs to have a good balance between functional and visual aspects. However, current research lacks a consideration of the interaction between space, furniture and people. Therefore, there

are still problems to solve, such as how to design a reachable windowsill or handle for wheelchair users, how to display the items in the living room for older people and more.

Therefore, the author investigated older people's needs in relation to furniture objects and the relationship between the furniture in the space. The results also showed older people's preferences of the furniture design and revealed a diversity of requirements and wishes. After combining space, furniture and atmosphere design elements in relation to older people's age-related changes, a comprehensive list of design insights is suggested below:

To consider older people walking around in living room:

- Ensure each piece of furniture has enough space to walk around
- Ensure the width of the door is easy to access
- Allow enough free space for older people to have enough space to walk around with a walking frame in the living room
- Ensure enough free space for older people to use a wheelchair in the living room.
- Ensure enough space to manoeuvre the wheelchair
- Ensure easy access from other rooms to the living room for wheelchair users.
- Ensure the living room door is wide enough to allow older people to pass through with a walking frame and wheelchair
- Ensure that the route to the other rooms are without obstacles (e.g. Steps)
- Avoid using mats on the floor as this might cause slipping/tripping issues
- Ensure the routes to access each function zone of the living room are short and without obstacles
- Ensure there is adequate empty space in front of the windows
- Avoid having extension cords of lamps out in the open as it might trip older people

When consider older people’s resting time in the living room:

- Ensure the sofa has a suitable height to sit comfortably
- Ensure the sofa has an armrest to allow older people to easily get up from it
- Provide space to allow older people to laterally transfer themselves from a wheelchair to a chair
- Provide multifunctional seating facilities to meet different requirements of older people, such as massage.
- Ensure the sofa provides good support for sitting posture
- Ensure the sofa provides good support for napping
- Ensure there is an appropriate distance between the sofa and coffee/side tables to allow older people easy access
- Ensure there is enough of a gap between the chair and coffee table/side table to allow older people to stand up.
- Enable older people to watch TV from a safe and comfortable position
- Ensure there are sockets near sofa area in a reachable position
- Ensure there is a light switch near the sofa to enable the light to be switched on and off directly from the sofa position.
- Ensure there is a comfortable light system for reading and watching TV
- Provide the opportunity to change the lighting colour for doing different activities
- Provide warmer and softer light as it might give older people a peaceful and more relaxing feeling
- Ensure the wall colour is light as older people's eyes need a brighter environment
- Ensure there is a good view through the window
- Ensure that the living room is well ventilated

To consider older people ‘s mealtimes in the living room:

- Ensure it is easy to serve food from the kitchen to the dining zone.
- Try to place the dining table outside the kitchen for convenient access to serve food
- Provide a serving hatch between the kitchen and the living room
- Ensure there is the ability to walk through from the kitchen to the dining zone easily and safely
- Avoid having rugs on floor that might cause tripping hazards when serving food.
- Ensure the dining table in a comfortable position
- Ensure the dining chair has arms to support to stand up
- Ensure the dining table is close enough to the television to fit entertaining needs
- Ensure there is an option to eat on the armchair

To consider for older people receiving others and socializing in the living room:

- Ensure there is the option to receive people and socialise in the space
- Provide extra space in the living room to allow for guests
- Ensure there is dining space for guests
- Have a foldable dinner table if the living room is small
- Ensure to design a maximize way to use the space with furniture to allow for socialisation
- Ensure furniture placement welcome visitors
- Avoid the need to move heavy furniture to entertain guests as it may hurt older people's back or shoulder.
- Ensure chairs can be easily moved from other rooms to the living room

- Ensure the door width is enough to carry chairs through
- Ensure there is good access around temporary furniture brought out to entertain the guest, to avoid bumping issues.

To consider for older people's activities and hobbies in the living room:

- Ensure the living room is sufficiently flexible to satisfy the different and changing needs of older people's occupants (such as jigsaw, painting)
- Ensure there is a space in the living room capable of being equipped for recreational activities (doing exercise)
- Ensure easy access to each function zone of the living room
- Avoid putting too many decorative items on the wall, as it could make the space feel crowded and messy
- Ensure pictures have a space-efficient way to lay out on the wall
- Ensure there is a good size and number of windows to have enough natural light to do daily home tasks and various actives (such as reading, take medicines, watching tv, etc.)
- Ensure there is an appropriate location of furniture (especially sofa or chairs) to gain enough natural light to read.
- Ensure there are blinds to control the amount of sunlight when their eyes feel glare.

To consider older people's cleaning in the living room:

- Ensure that lights in the living room can be easily cleaned
- Avoid the need to use ladders to do home cleaning
- Ensure there is a light-weight vacuum cleaner
- Ensure adequate space for ironing clothes
- Ensure chair/sofa design comes in a waterproof/stain proof material

To consider older people’s keep sense of safety and security in living room

- Ensure older people do not need to touch the hot surface of a radiator
- Ensure furniture has round corners to avoid injuries from bumping
- Ensure the window gives enough privacy from the outside world
- Might need a window screen to avoid bugs outside of the window
- Ensure to have an appropriate night light

Chapter 6. Thesis Conclusion

6.1 Introduction

The world population is ageing. Many researchers have explored and contributed to improving older people's quality of life from diverse perspectives, such as social care, healthcare, homes, transportation, and pension systems (ONS, 2018; Wittenberg and Hu, 2015; NICE, 2013; Kim et al, 2011; Martín, 2010). Healthcare homes, designed specifically for the older generation to provide a better physical environment and care service, have increased in the market in recent years. However, people aged 65+ might prefer to spend their later life in their existing homes or move to a smaller home that is easier to manage (AgeUK, 2017). In the home inclusive design research area, there has been a lack of research into elderly people's living room experience in the UK for those who want to stay in their own homes. This is the room where older people spend the majority of their time for daily activities (Appleton, 2002). As age increases, the body experiences decline in sensory function, mobility, balance, and memory (Farage et al, 2012). These changes can affect older people's living ability in a physical environment (Pinto et al, 2000; Schmall, 1991), which leads to difficulties doing daily activities or everyday household tasks. Moreover, there is a paucity of research that has explored older peoples' interactions between space, furniture and people in the living room at home. The research undertaken for this thesis fills this knowledge gap.

6.2 Research scope

From an ergonomics study aspect, a great deal of research has focused on the functionality and usability of home modification and adaptive devices, and how people interact with these products. However, the relationship between the furniture and environment was neglected from most of these studies, especially how the products have been used under different activities and circumstances in a living room in older people's homes. In the literature review chapter, the author outlined the research scope and presented a literature review conceptual framework for older people's age-related change and design factors in the living room environment. An understanding of how older people use their living room in terms of their interactions with objects, impact of living room layout, and atmosphere can contribute to identifying potential challenges and needs people face at home. This knowledge can be used to develop design insights for inspiring designers and other key stakeholders to improve living room design for this growing demographic group. Therefore, the aim of this research was to investigate the

experiences of older people with their living room at home so as to identify challenges and needs they face in their day-to-day life and to provide design insights for improving living room space design, furniture and furniture arrangement, and atmospheres design so as to improve older people's living room experience in the UK.

In order to achieve the research aim, four objectives and three research questions were considered; 1) study the home living situation and conditions of older people in the UK through the English Housing Survey 2012; 2) Investigate older people's living experience with their living room at home in the UK; 3) Identify the challenges and needs that older people face in their living room at home under different scenarios and analysis the reason behind it.; 4) Develop design insights and recommendations for improving living room environment design for older people in the UK.

Research questions were 1) How do older people currently use their living rooms for different activities and purposes? 2) To what extent do older people experience challenges and hazards in their living rooms? 3) How can we improve the living room environment for older people in the UK through better inclusive design?

6.3 Research methodology

To achieve the objectives, an ethnographic user study method was employed for this project. Results from the English Housing Survey have been analysed to explore the current living situation for older people in the UK and to develop the stratified purposeful sampling strategy for the qualitative methodology. The ethnographic user study approach was employed to explore older people's natural behaviour with multiple activities in their living room through video-based observation, in-depth interviews and cultural probes. Qualitative content analysis was applied to analyse the data collected, and in turn, to identify key factors that have an impact on older people's living experience in their living room. A framework for aging friendly living room design was developed (Figure 6.1) This framework can be used for designers, architects and other researchers to understand the key elements that need to be considered when designing an ageing-friendly living room environment. More research contributions from this research are summarised below.

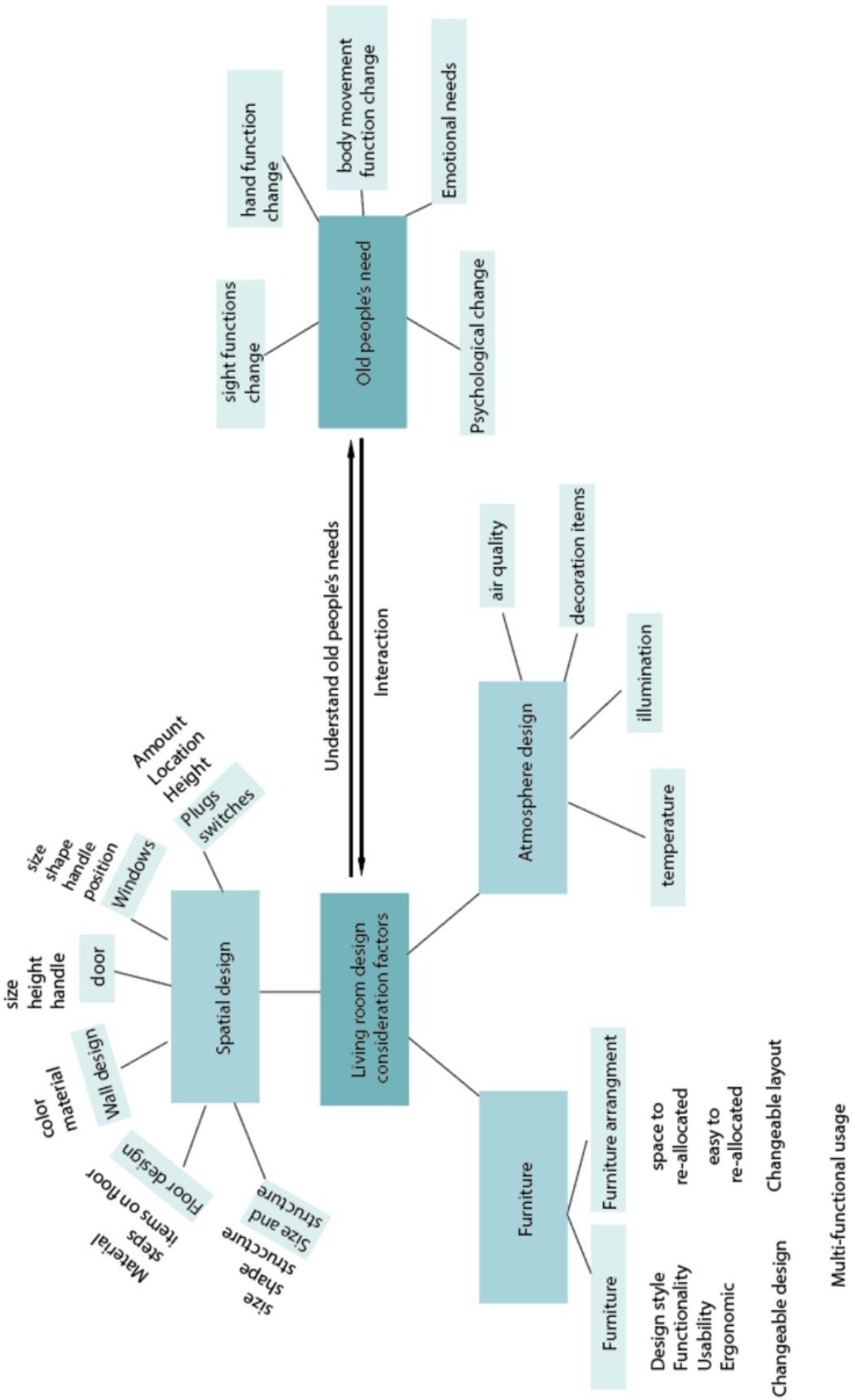

Figure 6.1 framework of ageing friendly living room design

6.4 Research contributions

This is the first study to focus on older people's living room design in the UK. The systematic review of how older people used their living room, and an identification of their unmet needs is suggested in relation to space, products, and atmosphere in the living room environment.

The result of this study developed coherent living room design insights to design ageing friendly living rooms. In particular, these insights can help designers and researchers to enhance their design thinking and to develop the current design guidelines for older people's living rooms. Insights can also be used for other environments in which older people live, such as care homes, giving interior designers, architects and service providers new design inspiration to meet older people's authentic needs. In addition, findings may inspire interior designers, architects and service design industries to find new business opportunities to provide services of tailored home design for the affluent senior market.

The theoretical framework of this research can be used as a reference system for a systematic analysis of older people's needs toward product types (such as sofa or tables) in the living room (or even other functional rooms). It will help the designers and researchers understand relevant factors of older people's needs and develop appropriate products for older people to use.

This study also provides an effective tool to understand older people's living room experience. It can be applied in other ageing-related research areas to explore older users' experience and behaviours, such as an ageing friendly hospital or care home design. It also provides insights for designers and researchers in methodology innovation in the related research field as a case study for the triangulation of interviews, observation and cultural probes. The study provides a reference point for how best to combine these methods for design research.

This project also helps policymakers to develop a better understanding of older people's living situations and their unmet needs. The design insights can help the policy maker to develop new home design criteria for older people. Moreover, the design insights could be used for spreading knowledge through newspapers or charity fliers to let older people themselves, their children or other relevant stakeholders understand the importance of appropriate living room design, and how to make a better living environment for older people. Therefore, it can help older people know how to protect themselves at home and motivate them to make the necessary adaptions that will enable them to live independently in their own homes for longer.

6.5 Key findings of this research

Combining older people's age-related change, older people's challenges and needs with the living room have been found and discussed. Chapter 4 focused on the living room space design (structure) and Chapter 5 focused on the furniture and furniture arrangement (objects) in the living room. In terms of the living room space design, older people's experience of the living room can be affected from 1) size and structure of the living room; 2) floor design of the living room; 3) wall design of the living room; 4) door design of the living room; 5) window design of the living room; and 6) plugs and switches in the living room. In terms of the living room furniture and furniture arrangement, it was found that older people's needs focused around, 1) lighting facilities; 2) furniture selection and key furniture design for older people in the living room; 3) furniture arrangement of the living room. Meanwhile, based on the observed issues, this study provided a list of design insights for each of these aspects.

This is therefore a unique research study. Though AD Part M (UK building standard) has provided a series of construction regulations for easy access to a building and a room, this regulation only worked for the new buildings built after 1999. For older build houses (before 1999), design and assess problems remain, such as the position of sockets and switches. Moreover, previous study mainly focusing on studying how to design an accessible environment for dementia sufferers and disabled older people (more for care homes) and do not cover healthy older people's use of their living rooms. Therefore, the findings of this research with design insights could inspire and help designers, architects, service providers, and other stakeholders related with ageing to improve the living room environment for older people in the UK through better inclusive design.

6.6 Research limitations

Although the benefits of using the ethnographic approach were analysed in Chapter 3, there are still some limitations for this research. The ethnographic observation takes place over a long period of time, making it a time-consuming process that may not be achievable in other contexts (Snell, 2011). Due to the limited time, the sample size of the ethnographic study in this research is another limitation (Hughes et al, 1995). Moreover, the challenges for analysing the results from a rich data collection are highlighted (Hughes et al, 1995). Moreover, from the user study, some furniture requirements were taken from the opinions voiced by the

participants, based on their understanding of their body conditions and knowledge of what furniture was fit for them to use in the later life. In the future, there should be a discussion with product/interior designers in order to consider these differing stakeholder perspectives. In addition, due to health conditions of the participants, a full data set could not be collected from each participant. Furthermore, participants completed the cultural probes in slightly different ways, and despite conducting a robust pilot study, we cannot assume that all of the participants completed each cultural probe in a consistent manner.

6.7 Opportunities for future research

In terms of the living room design insights, this study could be used for interior designers, architects, service providers and ageing-related stakeholders for further development of this study. This could give them inspirations and new design ideas for older people's home environment. The methodological approach could also be adopted to consider other rooms within the home, such as bedroom, kitchen or less-well considered spaces such as a conservatory.

This is therefore a unique research study. Comparing with the existing related research (HM Government, 2015; Mohammad, et al, 2014; Lifetime Homes, 2010), previous study mainly focusing on studying how to design an accessible environment for dementia sufferers and disabled older people (more for care homes) do not cover healthy older people's use of their living rooms. Furthermore, thought AD Part M (UK building standard) has provided a series of construction regulations for easy access to a building and a room, this regulation only worked for the new buildings built after 1999. For older build houses (before 1999), design and assess problems remain, such as the position of sockets and switches. Therefore, the findings of this research with design insights could inspire and help designers, architects, service providers, and other stakeholders related with ageing to improve the living room environment for older people in the UK through better inclusive design.

6.8 Chapter conclusion

This chapter, as the conclusion chapter of the whole thesis, has summarised the research background, research scope, research aim and objectives. In section 6.2 it has summarised the research scope. Section 6.3 has recalled the research methodology and presented the framework

of aging friendly living room design from this study. Research contribution has been discussion in section 6.4. Section 6.5 has reviewed the aspects of findings from this study, then pointed out this research's limitations in section 6.6. Finally, section 6.7 provided the opportunities for future development of this research.

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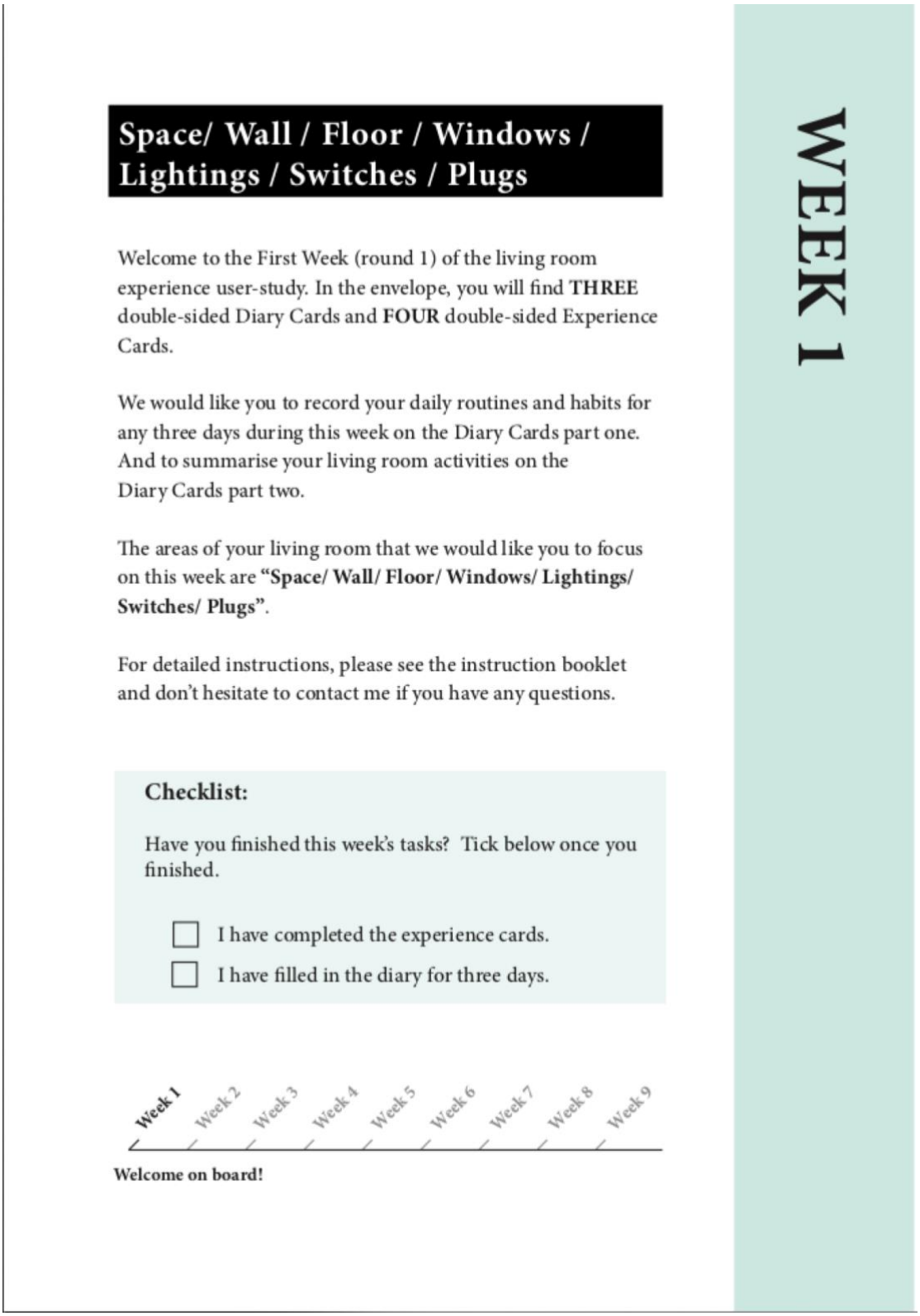
Appendix



WEEK 1

Space/ Wall / Floor / Windows / Lightings / Switches / Plugs

Welcome to the First Week (round 1) of the living room experience user-study. In the envelope, you will find **THREE** double-sided Diary Cards and **FOUR** double-sided Experience Cards.

We would like you to record your daily routines and habits for any three days during this week on the Diary Cards part one. And to summarise your living room activities on the Diary Cards part two.

The areas of your living room that we would like you to focus on this week are **"Space/ Wall/ Floor/ Windows/ Lightings/ Switches/ Plugs"**.

For detailed instructions, please see the instruction booklet and don't hesitate to contact me if you have any questions.

Checklist:

Have you finished this week's tasks? Tick below once you finished.

- ☐ I have completed the experience cards.
- ☐ I have filled in the diary for three days.

Week 1 Week 2 Week 3 Week 4 Week 5 Week 6 Week 7 Week 8 Week 9

Welcome on board!

Appendix 1 Week one introduction page of the culture probe

Appendix 2 Week two introduction page of the culture probe

WEEK 2

Furniture/ Furniture Arrangement/ Home Appliances/ Special-designed Products/ Decorative items

Welcome to the Second Week (round 1) of the living room experience user-study. In the envelope, you will find **THREE** double-sided Diary Cards and **FOUR** double-sided Experience Cards.

We would like you to record your daily routines and habits for any three days during this week on the Diary Cards part one. And to summarise your living room activities on the Diary Cards part two.

The areas of your living room that we would like you to focus on this week are **"Furniture/ Furniture Arrangement/ Home Applicances/ Special-designed Products/ Decorative items"**.

For detailed instructions, please see the instruction booklet and don't hesitate to contact me if you have any questions.

Checklist:

Have you finished this week's tasks? Tick below once you finished.

- ☐ I have completed the experience cards.
- ☐ I have filled in the diary for three days.

Week 1 **Week 2** Week 3 Week 4 Week 5 Week 6 Week 7 Week 8 Week 9

Good job! We are here now!

Appendix 3 Week three introduction page of the culture probe

WEEK 3

Natural light/ Ventilation/ Sounds/ Temperature

Welcome to the Third Week (round 1) of the living room experience user-study. In the envelope, you will find **THREE** double-sided Diary Cards and **FOUR** double-sided Experience Cards.

We would like you to record your daily routines and habits for any three days during this week on the Diary Cards part one. And to summarise your living room activities on the Diary Cards part two.

The areas of your living room that we would like you to focus on this week are **"Natural light/ Ventilation/ Sounds/ Temperature"**.

For detailed instructions, please see the instruction booklet and don't hesitate to contact me if you have any questions.

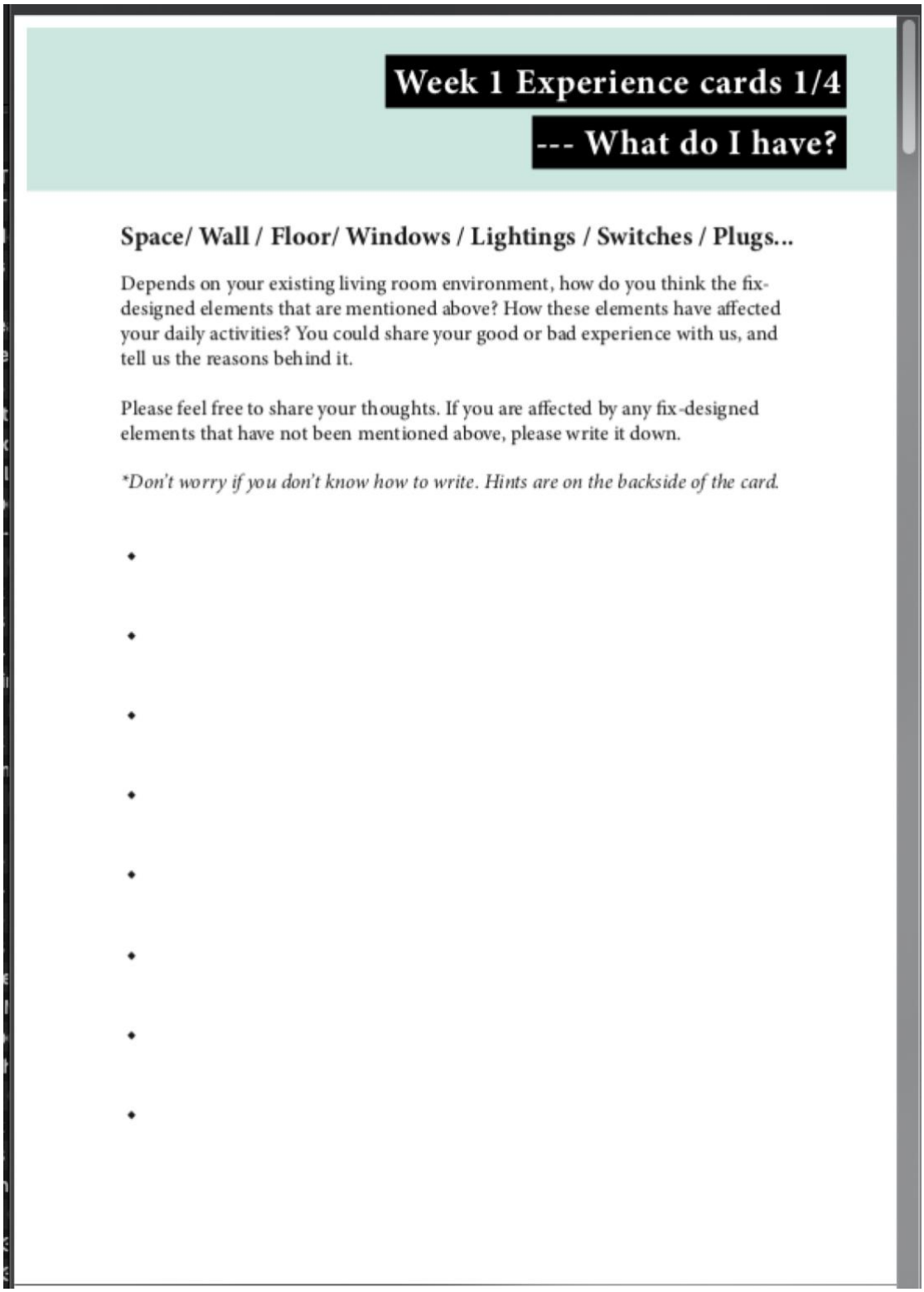
Checklist:

Have you finished this week's tasks? Tick below once you finished.

- ☐ I have completed the experience cards.
- ☐ I have filled in the diary for three days.

Well done! Round 1 is almost finished!

Appendix 4 Week one experience cards



Week 1 Experience cards 1/4

--- What do I have?

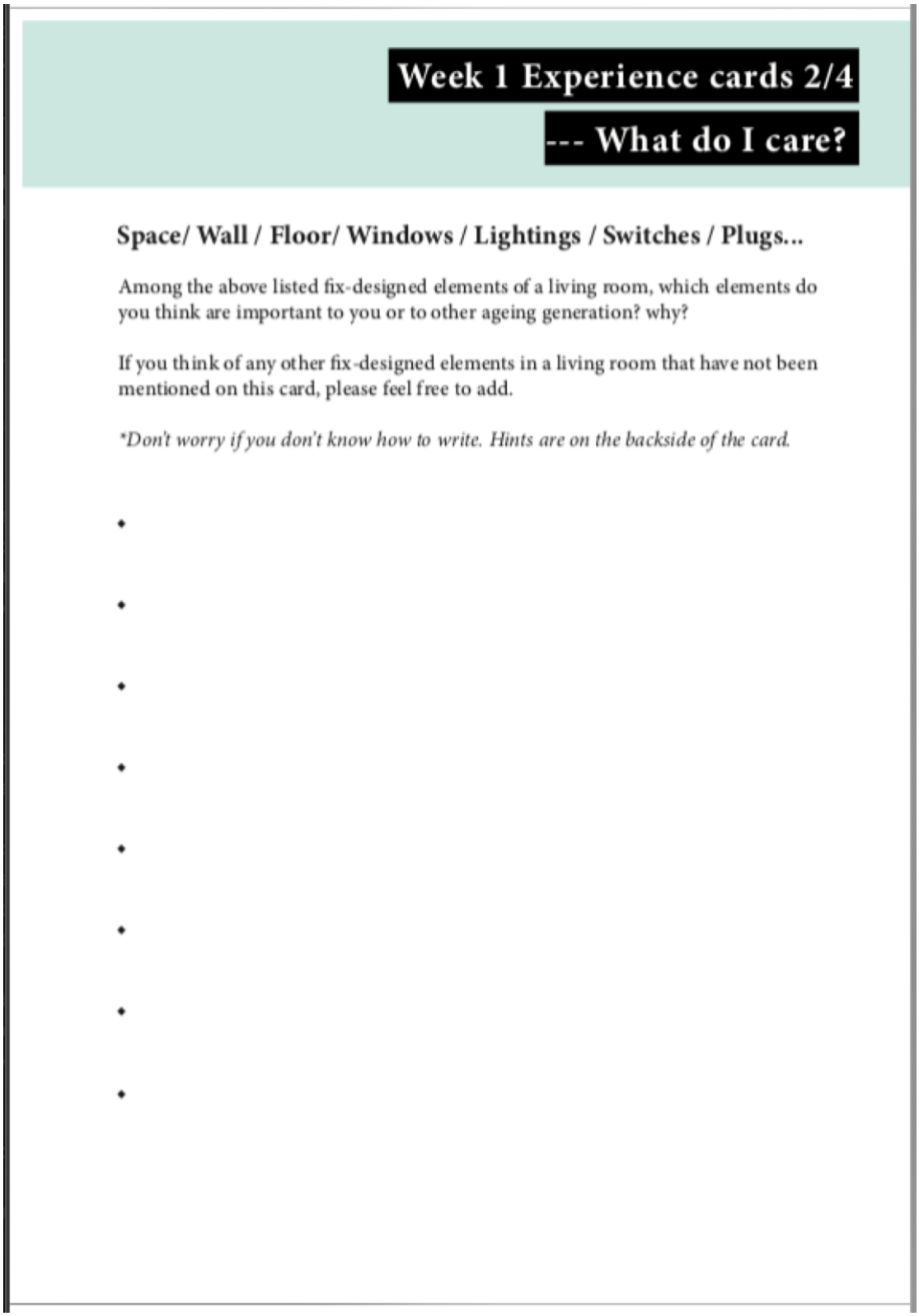
Space/ Wall / Floor/ Windows / Lightings / Switches / Plugs...

Depends on your existing living room environment, how do you think the fix-designed elements that are mentioned above? How these elements have affected your daily activities? You could share your good or bad experience with us, and tell us the reasons behind it.

Please feel free to share your thoughts. If you are affected by any fix-designed elements that have not been mentioned above, please write it down.

**Don't worry if you don't know how to write. Hints are on the backside of the card.*

Appendix 4: week one experience cards -2



Week 1 Experience cards 2/4

--- What do I care?

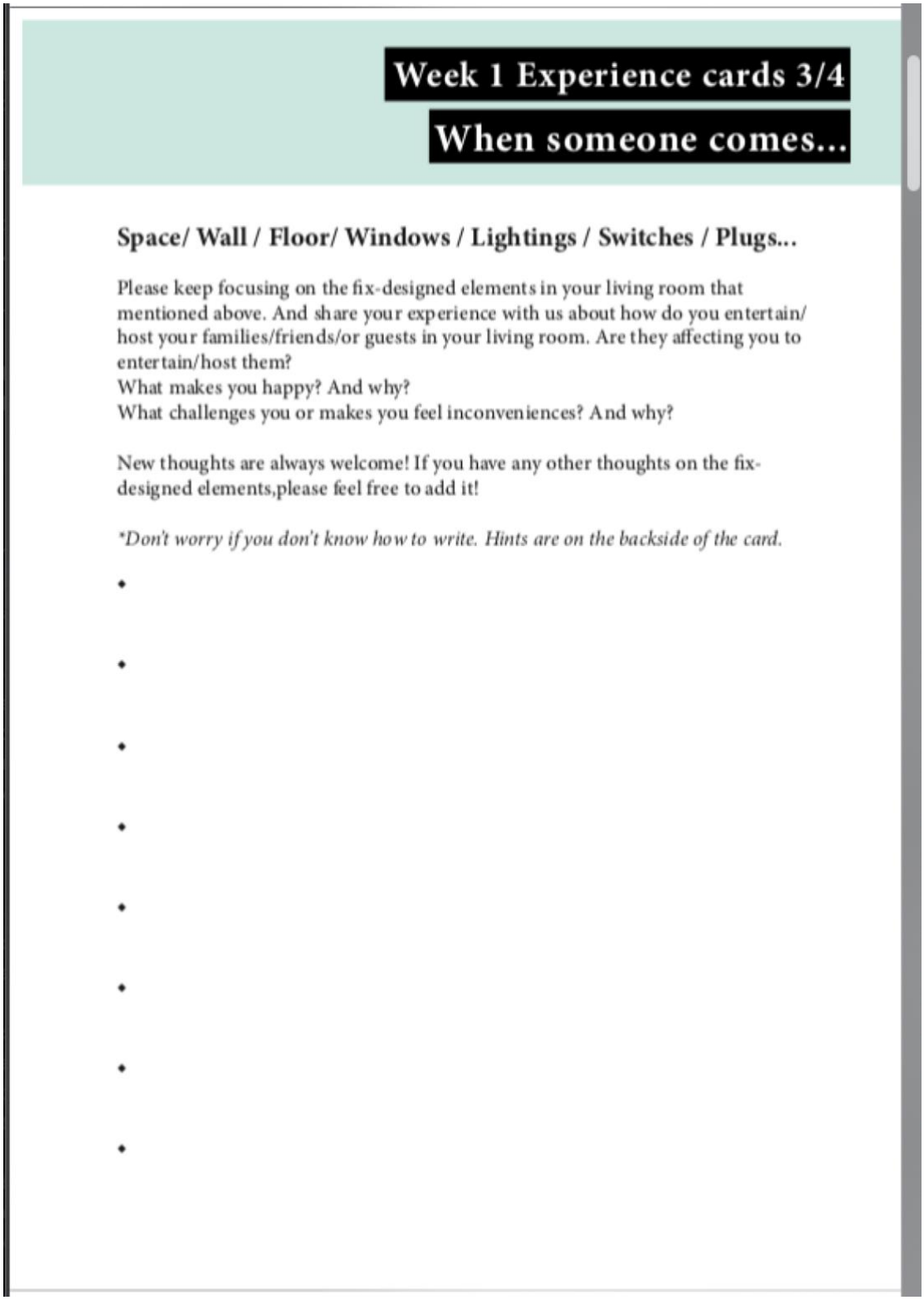
Space/ Wall / Floor/ Windows / Lightings / Switches / Plugs...

Among the above listed fix-designed elements of a living room, which elements do you think are important to you or to other ageing generation? why?

If you think of any other fix-designed elements in a living room that have not been mentioned on this card, please feel free to add.

**Don't worry if you don't know how to write. Hints are on the backside of the card.*

Appendix 4: week one experience cards -



Week 1 Experience cards 3/4

When someone comes...

Space/ Wall / Floor/ Windows / Lightings / Switches / Plugs...

Please keep focusing on the fix-designed elements in your living room that mentioned above. And share your experience with us about how do you entertain/ host your families/friends/or guests in your living room. Are they affecting you to entertain/host them?
What makes you happy? And why?
What challenges you or makes you feel inconveniences? And why?

New thoughts are always welcome! If you have any other thoughts on the fix-designed elements,please feel free to add it!

**Don't worry if you don't know how to write. Hints are on the backside of the card.*

-
-
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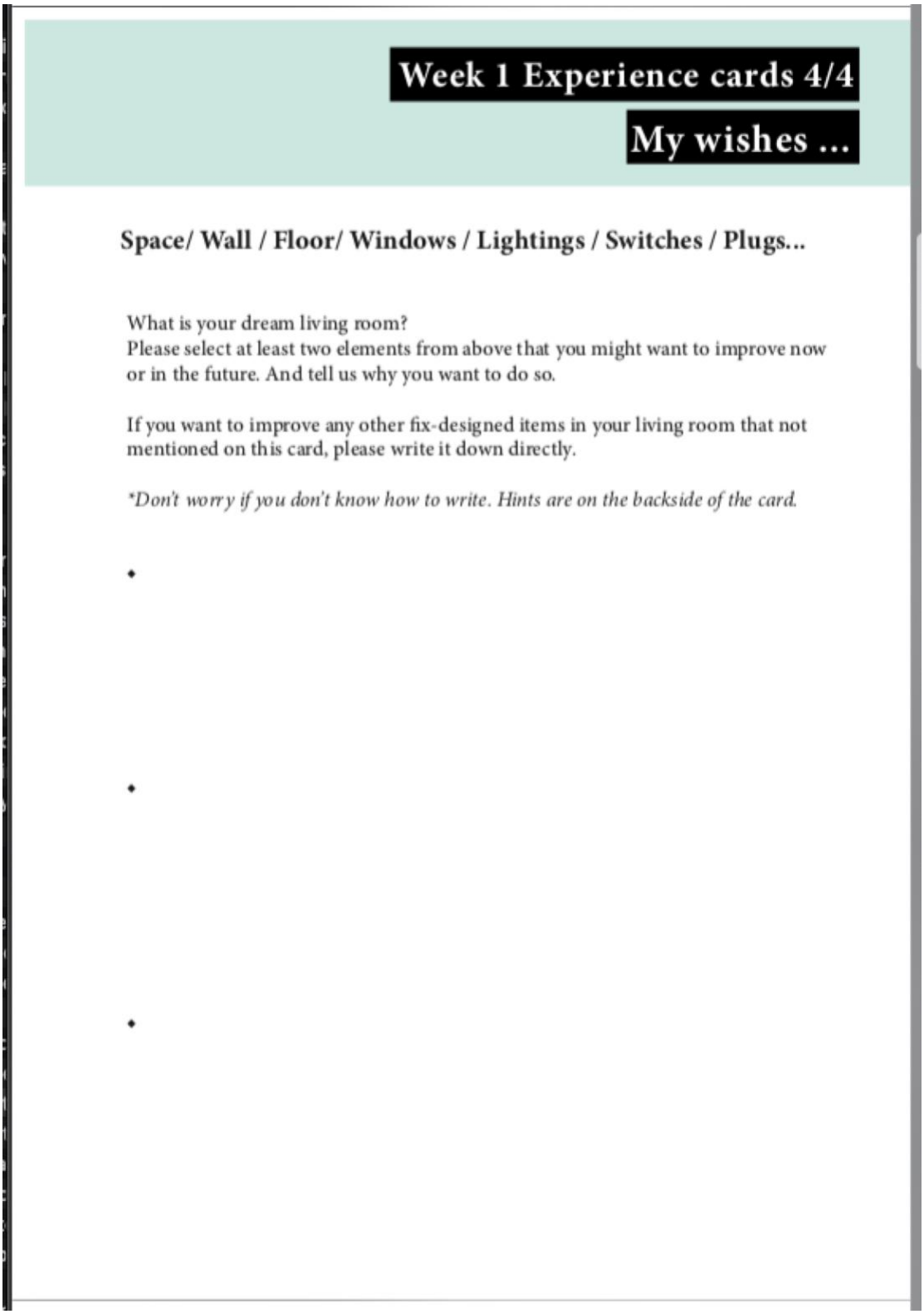
Appendix 4: week one experience cards -4



Week 1 Experience cards 4/4

My wishes ...

Space/ Wall / Floor/ Windows / Lightings / Switches / Plugs...

What is your dream living room?
Please select at least two elements from above that you might want to improve now or in the future. And tell us why you want to do so.

If you want to improve any other fix-designed items in your living room that not mentioned on this card, please write it down directly.

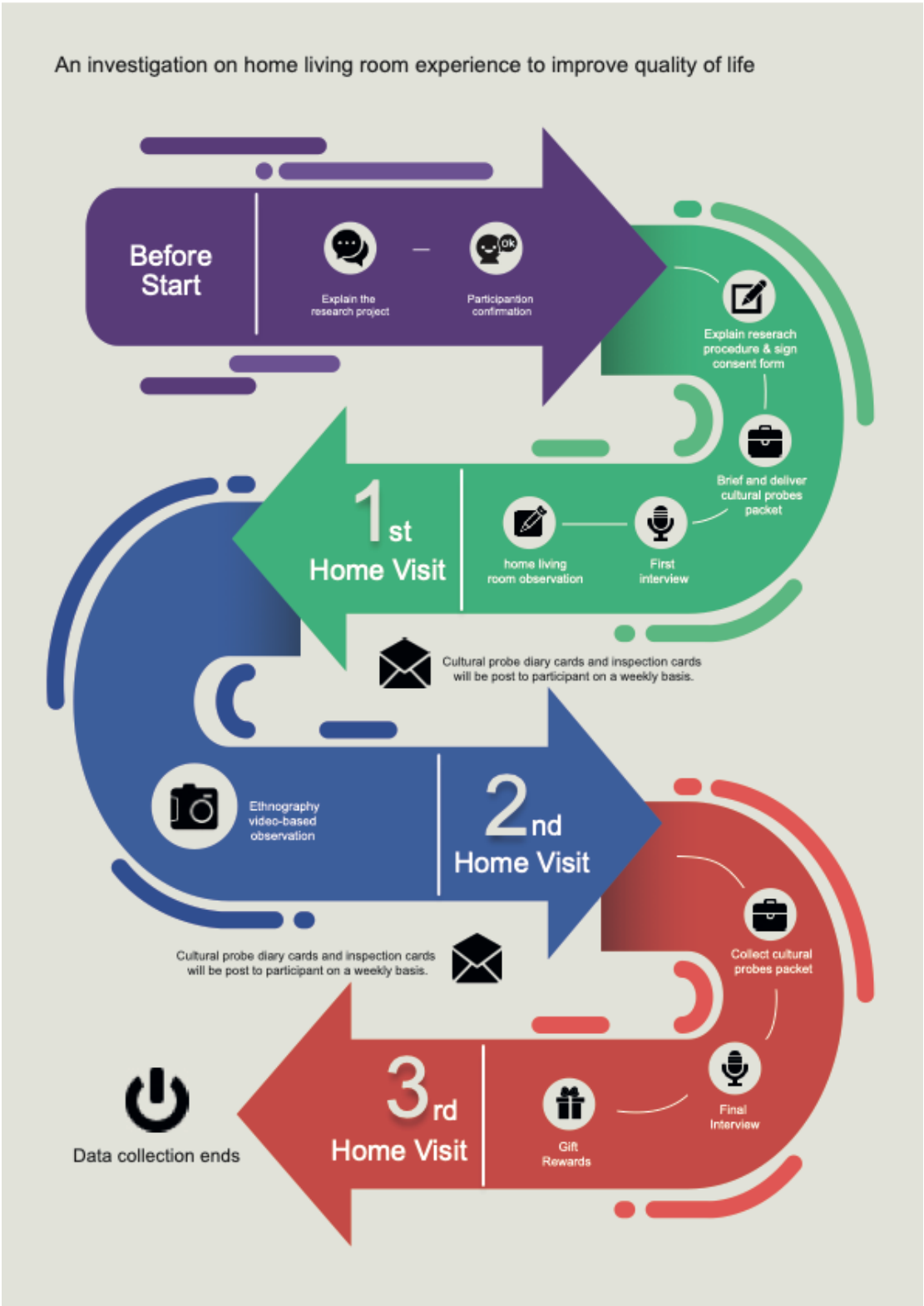
**Don't worry if you don't know how to write. Hints are on the backside of the card.*

•

•

•

Appendix 5 Procedure of ethnographic user study



Personal background interview

Respondent No. _____
Observation Date: _____

This is a guideline that helps the researcher to interview the participant personal background information during the 1st visit. Questions are divided into 4 sections.

Section 1: Personal information

1 Age band of the respondent 1) 65-75 2) 75-85 3) 85+

2 Sex 1) Male 2) Female

3 Marital status
1) Single 2) Married 3) Separated 4) Widowed 5) others _____

4 Number of household _____

5 How the people in your household are related to each other?

(1) Spouse,	(9) Parent-in-law,
(2) Son/daughter (incl. adopted),	(10) Brother/sister (incl. adopted),
(3) Step-son/daughter,	(11) Step-brother/sister,
(4) Foster child,	(12) Foster brother/sister,
(5) Son-in-law/daughter-in-law,	(13) Brother-in-law/sister-in-law,
(6) Parent / Guardian,	(14) Grand-child,
(7) Step-parent,	(15) Other _____
(8) Foster parent,	

6 What was your last job before retirement? _____

7 Are you still working or do any voluntary job?
If Yes, Please specify _____

(Continued)

Section 2: Health and wellbeing

1 How is your health in general?
(1) Very good (2) good (3) fair (4) bad (5) very bad

2 Do you have any disability or long-time illness? Is that affecting for your daily routines in your living room? How it affects you?

Example of disability/illness	**Affect daily activity (Yes/No/Not sure)**	**Reason (how affect for doing what?)**
Vision		
Hearing		
Learning difficulty		
Mobility		
Breathing problems		
Heart disease		
Mental health problems		
Others (please specify)		

3 Do you think your current body function that affects your daily routines in your living room? If yes, how it affects you?

Example of body function	**Affect daily activity (Yes/No/Not sure)**	**Reason (how affect for doing what?)**
Vision		
Hearing		
Hand motor function		
Mobility		
Body balance		
Others (please specify)		

If the participant indicates, "Yes", then ask,
How long has your ability to carry out daily activities been reduced?
(1) Less than six months,
(2) Between six months and 12 months,
(3) 12 months or more

(Continued)

4 Which mobility assistance do you use for your daily routines in your living room? How often do you use the assistance?

Example of assistance	**1) All the time 2) few times a day 3) few times a week 4) few times a month 5) occasionally**
Walking sticks	
Walking frames	
Wheelchairs	
Mobility scooters	
Others (please specify)	

5 How easy or difficult do you find to use your assistance in your living room, and why?

Example of assistance	**Level of difficulty**	**Reason**
Walking sticks		
Walking frames		
Wheelchairs		
Mobility scooters		
Others (please specify)		

* Level of difficulty (1) Very easy (2) Fairly easy (3) Neither easy nor difficult
(4) Fairly difficult (4) Very difficult

Next, I would like to ask you four questions about your feelings on aspects of your life. There are no right or wrong answers. For each of these questions I'd like you to give an answer on a scale of 0 to 10, where 0 is 'not at all' and 10 is 'completely'.

6 Overall, how satisfied are you with your life nowadays? (0-10)
7 Overall, to what extent do you feel that the things you do in your life are worthwhile?

8 Overall, how happy did you feel yesterday?

On a scale where 0 is 'not at all anxious' and 10 is 'completely anxious'

9 Overall, how anxious did you feel yesterday?

(Continued)

Section 3: Living situation

1 House location 1) Urban or 1) rural area

2 How easy to get public transport?

3 What's the dwelling type

4 Tenure Is this property…
(1) Owner occupied
(2) Rented privately
(3) Rented from a local authority or Housing Association

5 When was this property built?
(1) Before 1850
(2) 1850-1899
(3) 1900-1918
(4) 1919-1930
(5) 1931-1944
(6) 1945-1964
(7) 1965-1980
(8) 1981-1990
(9) 1991-1995
(10) 1996-2001
(11) 2002 or later

6 How long have you lived at this address?
(1) Less than 12 months
(2) 12 months but less than 2 years
(3) 2 years but less than 3 years
(4) 3 years but less than 5 years
(5) 5 years but less than 10 years
(6) 10 years or more

I would now like to ask you a few questions about any repairs or maintenances that have been done related to your living room in the last few years

7 Have you done any repairs/ or maintenances in your living room?

Example of maintenance in living room	**Details have done**	**Reason**
Floor		
Wall		
Window		
Lighting		
Furniture		
Technology facilities		
Heating system		
Others (please specify)		

(Continued)

8 How satisfy with your repairs/maintenances work have been done in your living room?

Example of maintenance in living room	Level of Satisfied	Reason
Floor		
Wall		
Window		
Lighting		
Furniture		
Technology facilities		
Heating system		
Others (please specify)		

**Level of satisfied: 1) very satisfied 2) Fairly satisfied 3) Neither satisfied nor dissatisfied 4) Slightly dissatisfied 5) Very dissatisfied*

9 Do you have any home service to make your life a little easier? And why you need this service?

Example of home service	Have/ Not have	If have, Reason
Domestic cleaning		
Carpet cleaning		
Furniture cleaning		
Meal service		
Care for houseplants		
Assist with pet care		
Others (please specify)		

(Continued)

Section 4: Health and safety issues at home

1 In recent years, did you have a fall/collision in living room?

If Yes Where did you [falls/collisions] in your living room?
Reasons of having that [fall/collision type]

2 What any other accident happed in your living room?

If Yes What accident ____
Reasons of having the ____ [accident type]

3 Do you feel any risks in your living room?

If Yes What risk ____
Reasons of having the ____ [risk type]

4 Do you feel anywhere inconvenience of doing daily activity in your living room?

If Yes What area ____
Reasons of that area inconvenience?

5 If give you a chance to re-design your living room, where do you want to change/or update?

Where? _____
Reasons of changing that area?

In-depth interview schedule

Respondent No. _____ Observation Date _____

The main topic of the in-depth interview is based on what kinds of activities that the participant has done during 2-3 hours video-based observation.

There is no right or wrong answer since this research aims to understand the participant viewpoints further.

12 factors will be asked depends on the activity the participant have done

Living room settled settings	*1) Floor, 2) Wall, 3) Window, 4) Lighting settings*
Living room moveable settings	*5) Furniture, 6) Specific-designed facilities/furniture, 7) Technology facilities, 8) Decoration items*
Living room ambience	*9) Light, 10) Ventilation, 11) Temperature, 12) Sounds*

1 Firstly, do you remember what you have done in the last 2 hours at your living room? (The researcher will review and summary the activities have done during the past 2-3 hours with the participant)
2 Could you please explain what settled settings in your living room, such as floor, wall window or lighting settings, are impact you _____, and how impact you?
3 How do you think the light/ventilation/temperature/sounds during your _____

4 Did you have any specific emotion with your (select one factor that related to the activity) during your _____ time?

Final interview schedule

Respondent No. _____ Observation Date _____

Thanks for your contribution during these 6 weeks. All your information is extremely precious to this research. I guess the questions we were asked during this 6-weeks are still remaining in your mind. I think now you know yourself much more than before, especially how your living room environment are important to you when you doing your daily routines at home. For the last interview, I would ask you some questions about how do you think of your living room circumstance.

12 factors will be asked by using the structures of the questions list randomly

Living room layout design	*1) Floor, 2) Wall, 3) Window, 4) Lighting settings*
Living room furniture arrangement	*5) Furniture, 6) Specific-designed facilities/furniture, 7) Technology facilities, 8) Decoration items*
Living room ambience	*9) Light, 10) Ventilation, 11) Temperature, 12) Sounds*

1 How do you think the _____ in your living room? Could you give an example to explain why?

2 How important of the _____ to you? Could you give an example to explain why?

3 Do you like the _____ in your living room? Could you give an example to explain why?

4 Is the _____ important to you or not, when you stay at your living room and do activities alone? Could you give an example to explain why?

Then asks …

1 If give you a chance to re-design your living room, where do you want to change/or update? (At least listing three areas)

Where?	
Why?	

Appendix 9 Fieldwork procedure for this research

Fieldwork	Time		Procedure
Sampling design			EHS secondary quantitative data analysis
Participant Recruitment			1. Split out leaflets* 2. Confirm participant 3. Sign agreement information sheet* 4. Decide the 1st advance visit date
Nine-week Ethnography user study	1st visit	Before	1. Contact participant to confirm the data and time 2. Check materials and digital equipment
		During (1.5 hrs.)	1. Introduce the research and the 1st visit procedure 2. Sign consent form* for ethnographic research 3. Finish Personal Background Interview*1 4. Introduce the Culture Probe pack 5. Ask and distribute the Nine-week culture probe content 6. Leave the 1st week culture probe cards*3 to the participant 7. Finish living-space observation*2 by the researcher alone 8. Test GoPro position 9. Discuss time for the 2nd visit
		After	1. Transfer interview audio to the researcher's laptop 2. Organize observation information 3. Prepare for the 2nd visit
	2nd visit	Before	1. Contact participant to confirm the data and time 2. Check materials and digital equipment
		During (4hrs.)	1. Introduce the 2nd visit procedure 2. Sign consent forms* for ethnographic research 3. Set up GoPro camera 4.Paticipant video-based observation 5. 1st In-depth interview*4 6. Collect and review the 1st week culture-probe cards with participant 7. Leave the 2nd and 3rd week culture probe cards*3 8. Discuss time for the 3rd visit
		After	1. Transfer observation video and interview audio documents to the researcher's laptop 2. Organize observation, interview and cultural probe cards information 3. Prepare for the 3rd visit

(Continued)

Appendix 9 (Continued)

Fieldwork	Time		Procedure
6-week Ethnography user study	3rd visit	Before	1. Contact participant to confirm the data and time 2. Check materials and digital equipment
		During (4 hrs.)	1. Introduce the 3rd visit procedure 2. Sign consent forms* for ethnographic research 3. Non-participant observation 4. 2nd In-depth interview*4 5. Collect and review the 2nd and 3rd week culture-probe cards with participant 6. Leave the 4th and 5th week culture probe cards*3 7. Discuss time for the 4th visit
		After	1. Transfer observation video and interview audio documents to the researcher's laptop 2. Organize observation, interview and cultural probe cards information
	4th visit	Before	1.Contact participant to confirm the data and time 2. Check materials and digital equipment
		During (1hr)	1. Introduce the 3rd visit procedure 2. Sign interview consent form* 3. Final In-depth interview*5 4. Collect and review the 4th and 5th week culture-probe cards with participant 5. Give rewards £50
		After	1. Transfer interview audio to the researcher's laptop 2. Organize interview and cultural probe cards information
Content analysis			1. Information compiling (naming, labelling, editing) 2. Data coding 3. Clustering information 4. Obtaining information

*Sign *: means that have a separate document (see document distribution below)*

Documents distribution:

*1 Personal Background Interview schedule (Appendix 6)
*2 Living Space observation schedule (Appendix 10)
*3 Culture Probe Activity Cards (Appendix 4)
*4 In-depth interview schedule (Appendix 7)
*5 Final interview schedule (Appendix 8)

Living Space Observation

Respondent No. _____
Observation Date: _____

This is a guideline that help the researcher to observe the participant living room surroundings during the 1st visit (This observation is done by research his/her self)

Sketch + Notes

1 Living room location within the whole living space

2 Living room shape/structure

3 Living room furniture arrangement

(Continued)

Measurement

1 Living room
size

2 Windows shape and size in the living room

	Width	Height
Window 1		
Window 2		
Window 3		

Picture taking + Notes (in Living room)

1 Floor surface Colour _____ Material _____

2 Wall surface Colour _____ Material _____

3 Windows (include skylights)
1) Position within the whole living room
2) Window shape

4 Lighting
settings
1) Un-movable lights position in living room Type ____ How many _____
2) Moveable lights position in living room Type ____ How many _____

5 Furniture settings

6 Any specific furniture? (Such as raising-up chairs)

7 Technology products (such as TV)

8 Decoration
items

Optional:

Assessment is this home match lifetime home standard?
(Followed by life time home design criteria:
http://www.lifetimehomes.org.uk/pages/design-criteria.html)

Appendix 11 sketch and note of the participant's living room from the author

1st visit .

Living Space Observation schedule

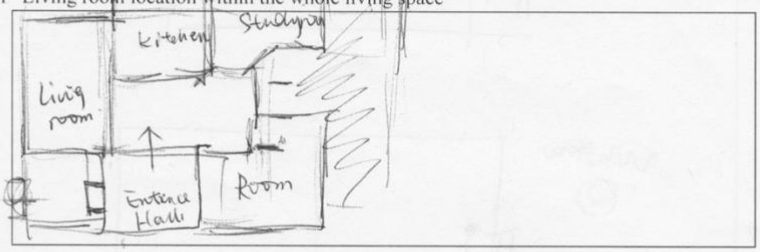
Living Space Observation

Respondent No. P07
Observation Date: 11th Sep 2017

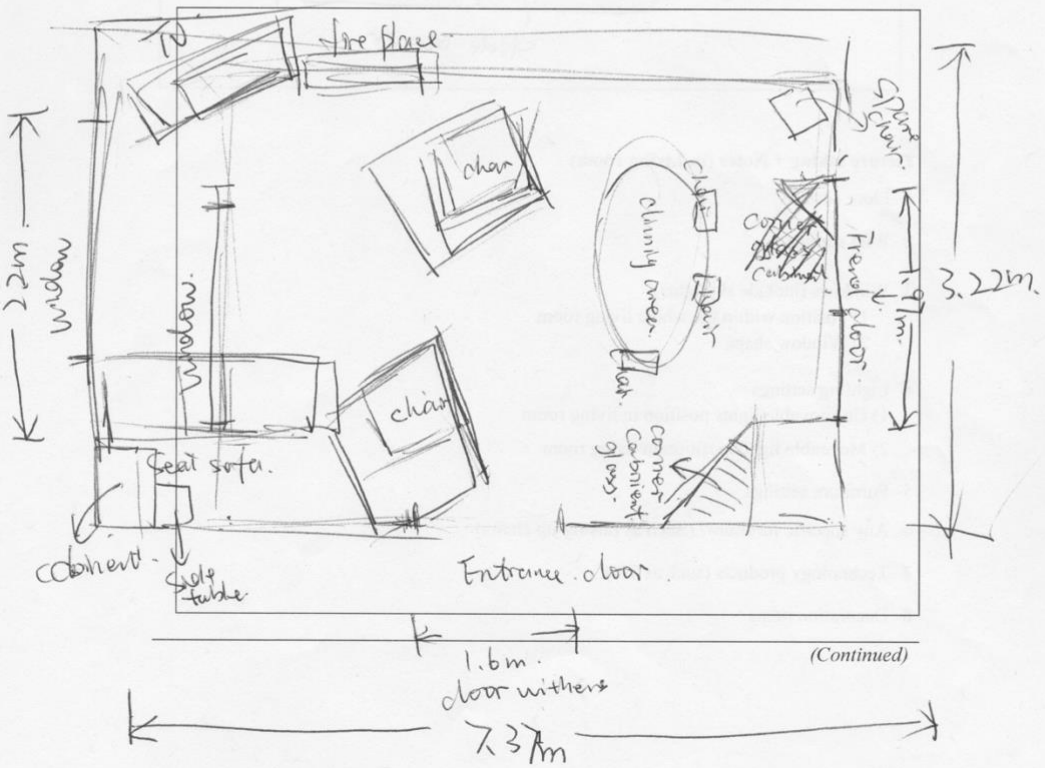
This is a guideline that help the researcher to observe the participant living room surroundings during the 1st visit (This observation is done by the researcher)

Sketch + Measurement + Notes

1 Living room location within the whole living space



2 Living room shape/structure, furniture arrangement



(Continued)

Appendix 11 sketch and note of the participant's living room from author

Living Space Observation schedule

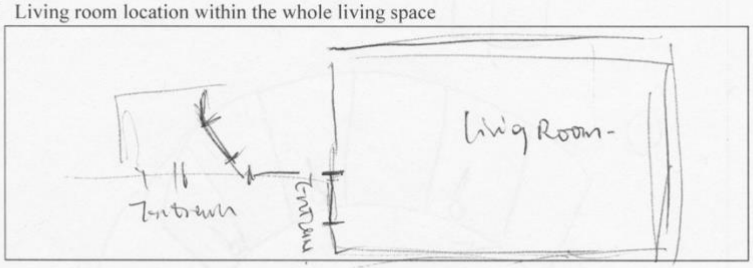
Living Space Observation

Respondent No. ~~8~~ P08
Observation Date: 11 Sep 2017.

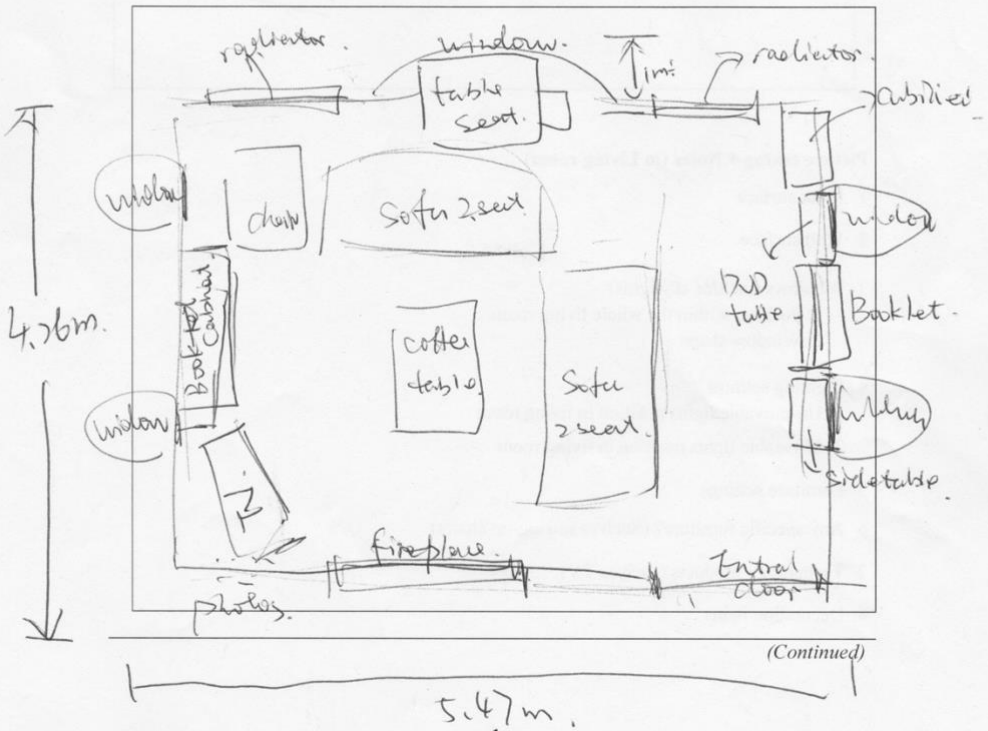
This is a guideline that help the researcher to observe the participant living room surroundings during the 1st visit (This observation is done by the researcher)

Sketch + Measurement + Notes

1 Living room location within the whole living space



2 Living room shape/structure, furniture arrangement



(Continued)

5.47m.

1