

# A holistic approach to balance energy renovation and aging-in-place needs for Dutch social housing

Energy transition in the existing building stock



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## Colophon



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## Preface

After completing my Bachelor's in Built Environment at the University of Applied Science in Amsterdam, I relocated to Delft to pursue a Master's in Management in the Built Environment. This journey has been one of significant personal growth, equipping me with a diverse skill set essential for professional practice. Working in multidisciplinary teams, engaging in design and research projects, participating in commissions, and competing in high-level rowing have honed my time management skills and shaped my professional identity over the years.

This research addresses two pressing global issues: the social challenge of an aging population and the environmental crisis of climate change. The built environment must adapt to mitigate greenhouse gas emissions while accommodating the needs of an aging population. I have always been passionate about housing for vulnerable individuals, recognizing that many measures can profoundly impact their lives. This sense of responsibility and care, coupled with my academic and practical experiences, has inspired my research question: how to integrate aging-in-place features into energy renovation for Dutch social housing.

The research contributes to understanding aging-in-place and energy renovation projects within housing associations. It explores the barriers and opportunities in integrating aging-in-place features into energy renovations, investigates the needs and preferences of aging social tenants, and draws lessons from best practices. This thesis aims to inspire housing associations, municipalities, healthcare organizations, contractors, and other market parties to collaborate and innovate, ensuring the energy transition of the building stock while improving housing design to facilitate aging-in-place.

I would like to thank my mentors, Queena Qian, and Angela Greco, for guiding me through the thesis process, providing valuable research tools and knowledge, challenging me to adopt new research methods, and their enthusiasm about my research topic. I also thank my parents for their unwavering support during my graduation project and their constructive feedback. Lastly, I am grateful to the interviewees for their participation; their valuable input has been instrumental in addressing these social and environmental issues. Without their contributions, this research would not have been possible.

Willemijn Gésanne Marijn Vos

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## Abstract

Globally, the aging population results in a large group of elderly people and not enough healthcare employees to take care of this group. Aging-in-place, the goal for older individuals to age in their homes is considered vital for their quality of life and to unburden the healthcare facilities. The demand for age-friendly houses is growing, necessitating a proactive approach to renovating homes for the elderly. Housing associations are expected to take the lead in the energy transition of the existing building stock, necessitating renovation of their portfolio to meet the energy requirements. Integrating aging-in-place features in the renovation plans of housing associations can help motivate the elderly to cooperate and approve of these plans continuing the energy transition, since 70% approval needs to be reached according to Ministerie van Algemene Zaken (2023), and responds to the needs of the aging population. This research will answer the question: how can aging-in-place features be integrated in energy renovations of social housing in The Netherlands? This study is researched through a literature study and (expert) interviews. The goal is to balance the needs for aging-in-place and energy improvement renovation projects to maximize the impact on the housing association and the elderly. The following strategy is proposed to overcome the barriers identified in the process of integrating aging-in-place features in energy renovations (1) collaboration with municipalities, elderly care providers, and housing associations to create urgency and align ambitions; (2) living coach and counselling to prepare aging social tenants for the future; (3) extra communication and guidance effort for elderly to mitigate resistance towards energy renovations; (4) collaboration and alignment with municipality and market parties to reduce barriers to implement aging-in-place initiatives and innovative care technologies.

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Keywords: energy renovations, aging-in-place, social housing, aging population



## Executive summary

### Introduction

Globally, the population is aging and in The Netherlands the age group of people above 75 in 2022 is prognosed to be doubled by 2050 (Aedes, 2018). The aging population brings challenges in healthcare because there are not enough employees to take care of twice as many elderly. Therefore, it is necessary that the elderly can live for as long as possible relatively independently at home, this is the concept of aging-in-place (Vanleerberghe et al., 2017). However, a third of people aged above 55 and 25% of people aged above 75 mention their homes are not suitable for aging-in-place (Centraal Bureau voor de Statistiek, 2020). Whilst, their preference is to stay at home for as long as possible and prefer to change the dwelling to be age-friendly and view moving as a last resort (Centraal bureau voor de Statistiek, 2020). Additionally, aging-in-place enhances the quality of life (Feng et al., 2018). Thus, there is a need for small-scale houses with age-friendly features for the elderly with a low to middle income (Ahli, 2019).

In the Netherlands, housing associations provide housing for the low-income group. The age group of households in social housing included 35% of people over 65 in 2018 (Aedes, 2018). The government expects housing associations to take the lead in the energy transition of the existing building stock due to their vast portfolio with comparable houses in The Netherlands. Globally, the climate is changing, therefore national goals are set to cut greenhouse gases by 55% by 2030. Renovation of the existing building stock is necessary to meet this national goal (Ministerie van Economische Zaken en Klimaat, 2020). The elderly are attached to their environment and prefer to stay in their current dwelling (Kooiman, 2020). However, housing associations have a standard design dwelling that is not suitable for aging-in-place, which can cause the elderly to have to relocate. Housing associations need 70% approval of their tenants to continue with the renovation plans (Ministerie van Algemene Zaken, 2023). Unsatisfied aging social tenants can cause conflict with this.

So on one hand, housing associations need to renovate their portfolio to meet energy requirements, and on the other hand, there is a need for houses with aging-in-place features for the elderly with a low to middle income. At the moment, those two needs are not integrated. The social houses are unsuited for aging-in-place and in the renovation plans, these needs are overlooked. Therefore, the gap is how to continue the energy transition in the existing building stock but also respond to the needs of the aging population. This tension will be studied with the following main research question: *How can aging-in-place features be integrated in energy renovations of social housing in The Netherlands?*

To answer the main research question, the following four sub-questions are studied:

1. What are the opportunities and barriers to integrating aging-in-place improvements in energy renovations of social housing in The Netherlands
2. What are the preferences and needs of aging social tenants for aging features blended in energy renovation?
3. What are the key learnings from initiatives to integrate aging-in-place improvements in energy renovations?
4. How to overcome the barriers when integrating aging-in-place improvements in energy renovations of social housing in The Netherlands?

## Research method

This study focuses on the challenges and opportunities associated with integrating aging-in-place improvements in energy renovations of social housing in the Netherlands, using a case study of a Dutch social housing association. The government expects housing associations to lead the energy transition due to their extensive building stock, which includes a significant percentage of older adults. Terraced houses are particularly common in the Netherlands and are the focus of this study due to their commonness and energy inefficiency. Furthermore, the research examines physical, social, and functional aspects to provide a holistic approach to aging-in-place improvements. Through an inductive approach, this study adopts a mixed-method research method. Interviews with managers from the housing association offer insights into barriers and opportunities at different organizational levels. Aging social tenants are interviewed, and quantitative research is conducted to gain comprehensive insight into the needs and preferences of this group regarding aging-in-place blended-in energy renovations. Additionally, interviews with external experts provide strategic perspectives on the integration of aging-in-place improvements in energy renovations. The research design is presented in Figure 1.

Data analysis is conducted through open coding, identifying primary codes and secondary themes to derive new theoretical insights. The study reveals conflicts between the preferences of aging social tenants and the objectives of housing associations regarding aging-in-place. Insights also emerge regarding the process response to energy renovations from both perspectives.

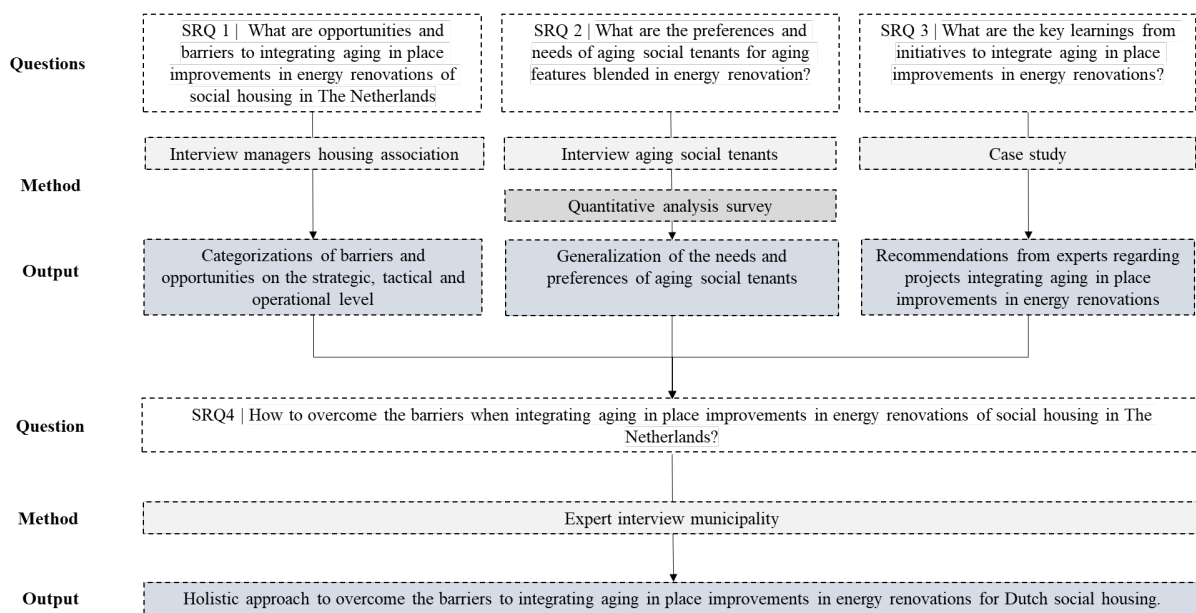


Figure 1 | Research design (own figure)

## Results

### *Theoretical research*

The World Health Organization (2012) defines quality of life as individuals' perceptions of their position in life relative to their culture, values, goals, expectations, standards, and concerns. Literature suggests that physical and social environment factors significantly enhance the quality of life among older people (Vanleerberghe et al., 2017). Elderly individuals prioritize social relations as the most important aspect contributing to their quality of life, followed by health, activities, functional ability, well-being, personal beliefs, attitudes, home environment, and personal finances (Wilhelmson et al., 2005). Aging-in-place, defined as the ability to remain living independently in one's home or community, is closely tied to the quality of life for older individuals (The World Health Organization, 2004).

A framework developed by Feng et al. (2018) outlines three dimensions for improving the housing environment of the elderly: personal safety, sensory comfort, and functionality of space, with sensory comfort being the most influential. Moreover, age-friendly environments create opportunities for the elderly to participate in activities and social interactions, positively impacting their health-related quality of life (World Health Organization, 2007). Lorkeers, Hooft, and Klaveren (2021) categorize home adaptations for aging-in-place into three degrees: casco adaptations, which are structural and integrated into the house framework, fixed adaptations that require breaking or damaging the house to remove, and portable adaptations like specialized lighting or brightness control devices that can theoretically be relocated to another home.

In the Netherlands, the government emphasizes the importance of "suitable" dwellings for aging-in-place, with specific requirements for accessibility and functionality (PBL, 2019). Housing associations play a crucial role in providing affordable and age-friendly housing for low-income individuals, addressing societal needs where the market falls short (Deursen, 2023a). However, challenges arise in renovating existing building stock to meet energy efficiency requirements, with considerations for tenant approval, cost, relocation, and evolving energy norms (Aedes, 2023). To address these challenges, housing associations collaborate with healthcare organizations and municipalities to provide appropriate housing for vulnerable groups like the elderly (PBL, 2019). They also navigate the complexities of energy renovations to meet legal standards and improve energy efficiency in their building stock (Ministerie van Economische Zaken en Klimaat, 2020; Aedes, 2023). Despite challenges, housing associations in the Netherlands have evolved into well-organized non-profits, prioritizing the needs of their tenants while balancing financial viability and social impact (Deursen, 2023b).

In conclusion, ensuring age-friendly and energy-efficient housing is essential for promoting the quality of life and well-being of older individuals. Collaboration between housing associations, government agencies, healthcare organizations, and communities is crucial in addressing the evolving needs of aging populations and achieving sustainable housing solutions (PBL, 2019).



### *Empirical research*

Several barriers were identified in the process of integrating aging-in-place features into energy renovations. These include varying levels of ambition among housing associations, inadequate preparation of aging social tenants for future housing needs, preconceived notions and uncertainties among tenants leading to resistance towards renovation, and delays in initiatives due to regulatory and permitting procedures.

To address these barriers, a strategic approach is proposed. This involves enhancing collaborations between municipalities, elderly care providers, insurance companies, and housing associations to foster urgency and awareness, align ambition levels, incorporate social aspects of aging-in-place, and optimize dwelling designs for the elderly. Providing counseling through a living coach can help prepare aging social tenants for their future housing needs while gaining insights into their preferences. Additionally, increased communication and guidance efforts tailored to the elderly are essential to support the energy transition and alleviate distress and uncertainty. Regulations and permit procedures delay initiatives for senior dwellings, highlighting the need for collaboration with municipalities to expedite permit processes. Additionally, to foster innovation in aging-in-place and energy transition, it's recommended to shift costs to market parties and enhance collaboration between housing associations, market entities, and care providers for the implementation of innovative care techniques and energy improvement systems. Incorporating housing allocation considerations into the regular operations of housing associations can further facilitate the integration of aging-in-place features into energy renovations

### **Conclusion**

The findings highlight the need for a coordinated approach involving housing associations, municipalities, healthcare providers, and other stakeholders to address the challenges of aging-in-place and energy efficiency. Strategies to overcome barriers include developing universal design principles, enhancing collaboration between stakeholders, and raising awareness of the importance of these issues.

Overall, the study emphasizes the urgency of responding to the needs of the aging population and addressing the energy efficiency of social housing. By understanding the complexities involved and adopting innovative strategies, stakeholders can work together to create more age-friendly and sustainable living environments for the elderly in the Netherlands.

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# Chapter 1 | Introduction

1.1 | Problem statement

1.2 | Research questions

1.3 | Goal & deliverables

1.4 | Dissemination and audience

1.5 | Research outline





# 1 | Introduction

## 1.1 | Problem statement

Energy use in buildings is responsible for 42% of the EU's total energy consumption in 2020, in which 35% of energy-related greenhouse gas emissions cause climate change (European Environment Agency, 2023; European Environment Agency, 2022). Therefore, the EU set a goal to be climate-neutral by 2050 and to cut greenhouse gas emissions by at least 55% by 2030 (European Council, 2023). The Netherlands implemented these goals in their national climate law (Ministerie van Economische Zaken en Klimaat, 2020). The Netherlands' housing stock consists of 8.045.580 houses of which 2.300.050 is owned by housing associations in 2022 (Centraal Bureau voor de Statistiek, 2023). The housing associations are expected to take the lead in the energy transition in the existing building stock due to their vast building stock with comparable houses (Ministerie van Economische Zaken en Klimaat, 2020). However, housing associations face challenges when improving the energy performance of their portfolio. According to Dutch law, a housing association's renovation plans must receive the approval of 70% of the tenants before they can be put into action (Ministerie van Algemene Zaken, 2023). The energy transition challenges are exacerbated for older people, individuals with the age above 65 years old, since there is a lack of support in this process and because of the cultural and technical barriers to accessing new sources of energy in everyday life (Žuk and Žuk, 2022). Older people are more vulnerable to climate change, for instance in case of extreme and prolonged heat and cold, the elderly are much more susceptible to heat stress compared to younger adults (World Health Organization, 2022). The World Health Organization (2022) emphasizes the urgency to collaborate among all stakeholders and make connections between climate change and healthy aging. Social housing in particular needs to cooperate with various stakeholders to improve the living conditions of elderly people, because older people in social housing are vulnerable due to standard design dwellings (Femenías et al., 2022). Femenías et al. (2022) also mention that renovation measures have been installed without the perspective of the elderly, which can result in relocation. Older people in social housing report more disabilities and illnesses, are worried about the future, and feel less safe at home. Fox et al. (2017) and Rollova and Filova (2023) suggest that social housing design should be adaptable to the needs of the tenants over time.

The age group of households in housing associations in The Netherlands included 35% of people over 65 in 2018 (Aedes, 2018). The age group of people above 75 in 2022 is prognosed to be doubled by 2050 (Aedes, 2018). More than 55% of adults between the ages of 60 and 70 lived at the same address for 20 years, and a third did so for more than 30 years in 2015, according to Kooiman (2020). Additionally, older people are more attached to their homes and neighborhoods and have no desire to move to a different living environment (Kooiman, 2020). Vanleerberghe et al. (2017) state as well that older people in Western countries want to remain in their familiar surroundings for as long as possible. Schmeets (2020) reports that in 2019, 6% of adults between the ages of 55 and 75 and 23,7% of those above the age of 75 received informal care. This means that this group is aging-in-place and needs care.

Aging-in-place refers to the policy goal of being able to stay in one's current location as one becomes older. The ability to mature in the home of one's choosing appears to have an impact on the quality of life of older people. Older people listed their home and neighborhood as one of the "good things" that made their lives worthwhile (Vanleerberghe et al., 2017). Older

people desire interdependence and prefer not to move, according to Vanleerberghe et al. (2017). Services and assistance should be made accessible to ensure interdependence. The concept of aging-in-place is broadened by Andrews et al. (2007) by including assisted living facilities, a type of supported senior housing. Negative side effects can also result from aging-in-place. The caregiver may feel burdened if access to essential services and accommodations is delayed. Second, the number of chores that need to be done can result in one's home becoming one's prison. The quality of life for older persons who are aging-in-place may also be threatened by poor informal support, a physically unsuited home and community, a weak social network, and insufficient health and social care services (Vanleerberghe et al., 2017). Therefore, it is necessary to renovate the homes of the elderly to have suitable homes for aging-in-place.

Additionally, Ahli (2019) recognizes that many homes are unsuited for older people currently and mentions that there is a growing need for small scale dwellings with assisted care for the elderly with a low to middle income. This is also due to the fact that the number of vulnerable elderly tenants within social housing is increasing. The process of renovating the homes of elderly to age-friendly dwellings is going to slow, a proactive attitude is needed and not reactive by adjusting homes after incidents. Furthermore, there needs to be a variety of homes with assisted care to meet the different needs of the elderly. Older people have a negative view on nursing homes, and would rather stay in their homes. This group wants to be part of a community, have commotion and social interaction, decide on what happens in the building, and want age diversity in the building (Ahli, 2019).

## 1.2 | Research questions

Resulting from the problem statement, on one hand, housing associations need to renovate their portfolio to meet energy requirements, and on the other hand, there is a need for houses with aging-in-place features for the elderly with a low to middle income. At the moment those two needs are not integrated. The social houses are unsuited for aging-in-place and in the renovation plans, these needs are overlooked. Therefore, the gap is how to continue the energy transition in the existing building stock but also respond to the needs of the aging population. Thus, the main research question is the following:

*“How can aging-in-place features be integrated in energy renovations of social housing in The Netherlands?”*

In order to answer the main research questions the following four sub-research questions need to be answered:

1. What are the opportunities and barriers to integrating aging-in-place improvements in energy renovations of social housing in The Netherlands
2. What are the preferences and needs of aging social tenants for aging features blended in energy renovation?
3. What are the key learnings from initiatives to integrate aging-in-place improvements in energy renovations?
4. How to overcome the barriers when integrating aging-in-place improvements in energy renovations of social housing in The Netherlands?



### 1.3 | Goal and deliverables

The national goal is to cut greenhouse gases by 55% by 2030. Alongside this environmental challenge, The Netherlands faces the social challenges of the aging population. The goal of this research is to find out how aging-in-place features can be integrated in energy renovation of housing associations in The Netherlands, to respond to these challenges. This results in the main objective of this research: “This thesis aims to explore what housing associations can do to integrate aging-in-place features in energy renovations”.

### 1.4 | Dissemination and audience

This study is intended for housing associations. It is meant to provide guidelines on how aging-in-place improvements in energy renovations can be integrated. Additionally, it is to create awareness of the unpreparedness of our building stock to address the challenges of the aging population and energy transition.

### 1.5 | Research outline

Chapter	Content
<b>1   Introduction</b>	In the introduction is the problem statement described, of which the research question and sub-questions are formulated. A conceptual model is presented to visualize the outputs of the research question. The research output includes the goals, deliverables, dissemination, and audience.
<b>2   Literature research</b>	The literature research studies different aspects relevant to the topic, such as aging-in-place, housing associations, energy renovation, and aging tenant preferences are studied. These topics are integrated into a theoretical framework.
<b>3   Research design</b>	The research method includes the context of the research, the research design, data collection, data analysis, data plan, and ethical considerations
<b>4   Empirical research</b>	This chapter presents all the data resulting from the interviews and is analyzed here. This includes all the data from the sub-questions.
<b>5   Discussion and conclusion</b>	This chapter concludes all the results from the empirical research. Furthermore, the discussion includes my perspective on the results, advice to practice, and advice to researchers. Limitations to this study are presented last.
<b>6   Reflection</b>	This chapter includes a reflection on the results, the research process, and the planning

# Chapter 2 | Theoretical background

2.1 | Quality of life aging-in-place

2.2 | Living preferences of people aged 65 and above

2.3 | Dutch housing associations

2.4 | Energy renovations

2.5 | Opportunities and barriers

2.6 | Integrated theoretical framework





## 2 | Theoretical background

### 2.1 | Quality of life and aging-in-place

The World Health Organization (2012) defines the quality of life as *“individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns”*. Literature shows that physical and social environment factors enhance the quality of life among older people (Dahlan et al., 2016; Lee & Cheong, 2018). Older people are defined as humans with a chronological age of 65 years old or older (European Union, 2022; Orimo et al., 2006). According to Wilhelmson et al. (2005), the elderly considered social relations to constitute most to the quality of life, followed by health, activities, functional ability, well-being, personal beliefs and attitudes, their own home, and personal finances. Therefore, not only the physical but also the social factors should be considered. The ability to age in the home of one's choosing also appears to have an impact on the quality of life of older people (Vanleerberghe et al., 2017). The World Health Organization Centre for Health Development (2004, p.9) defines aging-in-place as *“meeting the desire and ability of people, through the provision of appropriate services and assistance, to remain living relatively independently in the community in his or her current home or an appropriate level of housing. Aging-in-place is designed to prevent or delay more traumatic moves to a dependent facility, such as a nursing home”*. Additionally, aging in place and quality of life are inextricably linked.

Aging at home is often desired by older individuals, but functional health status and unsuitable environments can be significant barriers according to Ajani & Olapade (2024). These barriers stem from progressive declines in physical and mental health, which alter the biological, environmental, and socioeconomic needs of the elderly. Age-related health issues, such as neurodegenerative disorders, mobility impairments, sensory function deterioration, and chronic diseases, can significantly limit the ability of older persons to perform daily tasks, navigate their environment, and ensure their safety, necessitating adaptable and supportive home environments. Most environmental barriers to aging-in-place can be reduced with advanced planning for building design retrofits and smart home technology adaptation, unlike age-related health barriers, which are frequently progressive and unpreventable. People who opt to age in place, however, might occasionally require adjustments to their living space to allow for new health issues and psychosocial requirements because the demands of aging are variable. As a result, the building's design must be easily modified to accommodate the changing needs of the elderly, as determined by their socioeconomic and health requirements. In addition to guaranteeing safety, this also makes sure that the environment is appropriate to lessen, overcome, or compensate for the physical needs of the elderly rather than creating new obstacles or health risks for the person who has chosen to age in place (Ajani & Olapade, 2024).

Feng et al. (2018) developed a framework to improve the housing environment of the elderly, allowing them to age in place which will enhance their quality of life, see Figure 2. This framework gives three dimensions in which the indoor housing environment can be improved, personal safety, sensory comfort, and functionalities of space. World Health Organization (2015) confirms that aging-in-place considers these three dimensions by stating that home modifications generally address one or more of the following three issues: (1) physical accessibility, which includes removing obstacles like stairs at the entrance and providing mobility and safety aids, such as grab bars in showers and near toilets; (2) comfort,



enhancements such as improving energy efficiency by installing insulation and draught proofing; (3) safety, measures to reduce airborne dust and introducing mechanisms to reduce injury, such as installing nonslip flooring in bathrooms. Sensory comfort is the most influential and should be improved first (Feng et al. 2018). According to Aedes (2022) the elderly value stability and safety the most in their housing environment, this confirms that the dimension of personal safety is important to consider. According to the World Health Organization (2007), ‘age-friendliness’ creates opportunities for the elderly to participate in activities and to stimulate mobility in the neighborhood and community. Munford et al. (2017) state that the elderly who participate in community assets have a higher health-related quality of life. Feng et al. (2018) acknowledge this and added the improvement of space for activities and socialization in the framework to achieve this. Vanleerberghe et al. (2017) consider the same aspects as Feng et al. (2018) to contribute to the quality of life; the opportunity to participate in meaningful activities, a pleasant physical environment, an environment or venue that facilitates close relationships and social interaction, and a sense of security about one's health and safety all contribute to the quality of life experienced by older individuals residing in institutions.

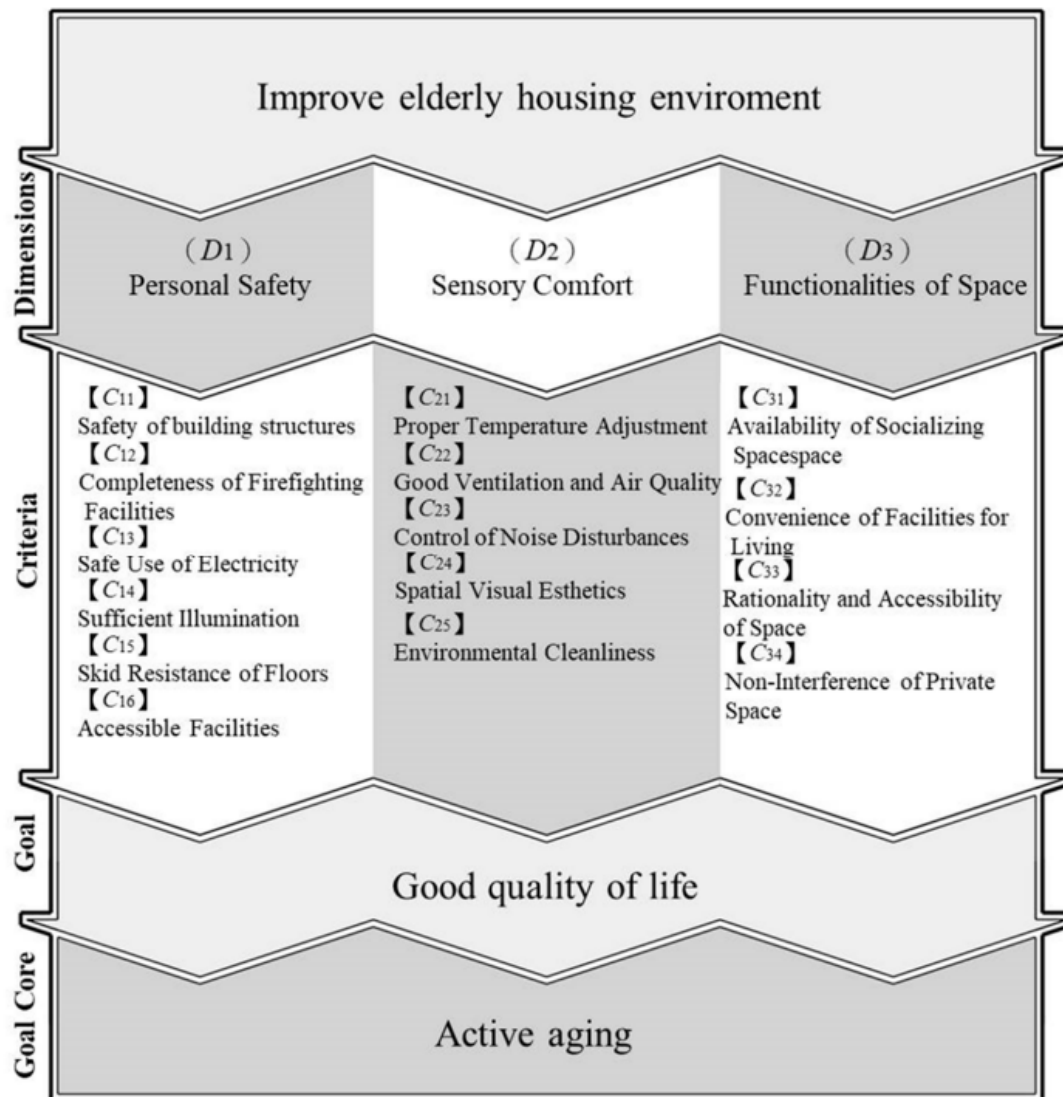


Figure 2 | Housing environment improvement framework (Feng et al., 2018)

Lorkeers, Hooft & Klaveren (2021) divide home adaptations for aging-in-place into three degrees. The first degree is the casco, including home adaptations that are structural, and integrated into the main framework of the house, such as wider doors and larger rooms like a spacious bathroom or a large hallway with sufficient space for a wheelchair to turn around. The second degree is fixed adaptations, which can only be removed by breaking or damaging the house. Examples of these include a lowered kitchen or a specially adapted bathtub. The last degree is portable home adaptations that can theoretically be moved to another home. These include items such as specialized lighting or brightness control devices (Lorkeers et al., 2021). Combining the three dimensions of the housing improvement framework by Feng et al. (2018) with the three degrees on which home adaptations can be categorized by Lorkeers et al. (2021) results in the model in Figure 3. The aging-in-place improvements for the criteria defined in the housing improvement framework can be categorized in different degrees.

		<b>Dimensions</b> (Feng et al. 2018)		
		<i>Personal safety</i>	<i>Sensory comfort</i>	<i>Functionality of spaces</i>
<b>Degrees</b> (Lorkeers et al. 2021)	<i>Casco</i>			
	<i>Fixed adaptations</i>			
	<i>Portable home adaptations</i>			

Figure 3 | Aging-in-place features categories (own figure based on Feng et al. (2018) and Lokeers et al. (2021))

Construction of age-friendly housing starts with the conceptualization and design phase. Ideally, all residential buildings should be designed to meet the needs of their future occupants. According to Shelby County (2015), the "universal design concept" in building design refers to designs that include features that are usable by the majority of people, regardless of their level of ability or disability. Although accessible design and adaptable design are also commonly used synonymously with universal design, there are some subtle distinctions between the two concepts. The concept of universal design is to take into account the needs of all individuals, regardless of ability or disability, when designing a building. Although the focus of accessible design is on fulfilling the specifications for accessible housing, which include having wide doorways, enough room for a wheelchair to maneuver, and other permanent, visually apparent health and safety measures in a dwelling. In contrast, the adaptable design leaves out accessible features until required. Universal design therefore includes both adaptable and accessible design components (Shelby, 2015). Wider doorways and hallways, hard-surface flooring with non-slip tiling, open floor plans, ramps or lifts for any level changes, doors with lever door handles, and bathroom grab bars are some of the

most typical features of a universally designed home (World Health Center, 2015). Other features include windows at different heights with low sills, lowered light switches, raised electrical outlets, and sliding and adjustable cabinet shelves (Shelby, 2015). Some universal design home requirements for the elderly are shown in Figure 4, which are categorized according to Lorkeers et al. (2021) degrees and dimensions proposed by Feng et al. (2018). These are some examples, however there are more design specifications proposed by literature.

Degrees Lorkeers et al. (2021)	Dimensions Feng et al. (2018)		
	<i>Personal safety</i>	<i>Sensory comfort</i>	<i>Functionality of spaces</i>
	<i>Casco</i>	No steps Electrical sockets, HVAC control, and switches fixed at height 120 height	Floor heating Insulation façade, floor, roof Double glazing Ventilation system
	<i>Fixed adaptations</i>	Bathroom near bedroom Wide doorways and stairs (at least 90cm width) Door entrances at least 150cm turning radius	Skid-resistant floor and stairs Ramp from entrance to street Electric cooking Adapted bathtub
<i>Portable home adaptations</i>	Temperature adaptation Spatial visual esthetics	Basin height to 80cm with clear space underneath Raised or lowered kitchen Raised toilet Lowered door cabinets	Grab bars, handrails, and vertical bars in the bathroom Alarm bell Medicine dispenser
	Automatic vacuum cleaner Brightness control devices	Shower blow dryer Stairlift	

Universal design specifications for the elderly (Ajani & Olapade, 2024; World Health Center, 2015; Shelby county, 2015)

Figure 4 | Universal design specifications for the elderly categorized in the framework. (Feng et al.,2018; Lorkeers et al., 2021; Ajani & Olapade, 2024; World Health Center, 2015; Shelby county, 2015)

In the Netherlands, the government uses the term “suitable” dwelling when referring to age-friendly homes. A suitable dwelling for the elderly has a bedroom, bathroom, and toilet that are accessible from the living room without using stairs (PB, 2019). Interviewee 2, a social manager within a housing association, has defined four levels of age-friendly dwellings. The first level is a dwelling that is reachable with a walker. Second level, the dwelling needs to be reachable and accessible by a walker. The third level, the dwelling needs to be wheelchair appropriate and the last level is a dwelling that is extra spacious and appropriate for a wheelchair. Each level has different requirements. An example is provided in Figure 5 to demonstrate the minimum accessibility requirements for a dwelling, as formulated by a housing association through an exploratory interview.

Level 1   Walker reachable dwelling	Level 2   walker reachable and accessible dwelling	Level 3   wheelchair dwelling	Level 4   Extra spacious wheelchair dwelling
Dwelling on ground floor or accessible with elevator	No stairs or access with elevator	All the requirements from level two plus:	All the requirements of level 2 and 3 plus:
Dwelling without stairs	Doorstep with a maximum of 2 cm	All doors, hallways and elevators have a minimum width and size	Livingroom with a minimum floorspace of 24m <sup>2</sup>
Doorstep with a maximum height of 2cm	hallways to complex and or dwelling are minimal 1,2 meter wide	Residents can easily move around in a wheelchair in the complex or dwelling	Bedroom with a minimum floorspace of 15m <sup>2</sup>
Mobility scooter parking space	Entry doors and elevator door open automatically	Doorbell and buttons are low	
Videophone doorbell	Passage of doors in dwelling are minimal 75cm wide	Bathroom without a step	
	Passage of doors in communal areas are at least 85 cm wide	Kitchen is spacious	
	Enough space in elevator for a walker including a handle bar		
	Ramp degree is limited		
	Tag entrysystem		
	Burglary protection		
	Floors with sensors that capture when someone falls		

Figure 5 | Different types levels of elderly homes with requirements (explorative interview 2, housing association)

For elderly individuals to live independently, the living environment must be age-friendly. Both the dwelling and the neighborhood need to be considered to achieve aging-in-place. According to PBL (2019), the suitability of dwellings for aging-in-place is determined by three factors, physical, functional, and social factors. Functional factors are for example the facilities in the neighborhood and social factors are social activities in the neighborhood or in the building. Bigonnesse and Chaudhury (2021) confirm the importance of the living environment contributing to aging-in-place, including the social and functional factors, and present a conceptual framework for aging-in-place in the neighborhood environment, see Figure 6. In this conceptual framework, aging-in-place is influenced by five central components: place integration, place attachment, independence, mobility, and social participation. These components are affected by four factors: individual characteristics, accessibility of the built environment, proximity to services and amenities, and meaningful social connections. The framework highlights that each component directly or indirectly connects to aging-in-place, with mutual influences among them, such as how mobility supports place integration and, subsequently, place attachment. Changes in any of these components or factors can disrupt place integration, demonstrating the interconnectedness and complexity of aging-in-place (Bigonnesse and Chaudhury, 2021).

Individual factors crucial to aging in place include physical health and psychological characteristics like agency and resilience according to Bigonnesse and Chaudhury (2021). Physical health influences all aspects of aging-in-place especially for those in walkable neighborhoods with plentiful services and active communities. Psychological characteristics, such as agency, allow older adults to make meaningful decisions and maintain functional abilities and social networks, even when moving to new environments. Resilience helps them adjust to challenges. The accessibility of the built environment, including homes and neighborhoods, supports mobility and independence. Proximity to essential services and amenities like groceries, pharmacies, and social spaces fosters aging-in-place by enhancing mobility and social participation. In The Netherlands primary facilities such as a pharmacy, doctors, supermarkets, and public transport, need to be within a 500-meter range from the

residents of the elderly to be considered age-friendly (PBL, 2019; explorative interview 2). Meaningful social connections, both formal and informal, reduce isolation and enhance place attachment and integration. Social participation, including volunteering and community engagement, strengthens aging-in-place by fostering connections and a sense of belonging. Mobility, especially walking, is central to aging-in-place, supporting access to resources and social interactions, and is facilitated by accessible transit and services. Independence, influenced by social support and participation, allows older adults to control their environment and meet daily needs (Bigonnesse and Chaudhury, 2021).

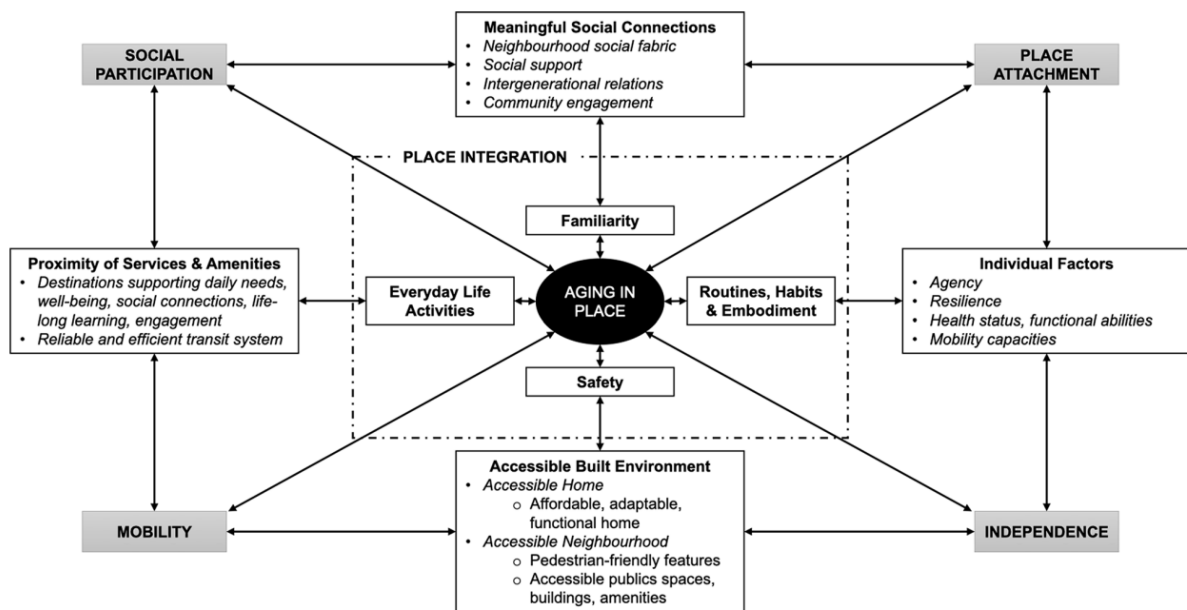


Figure 6 | Conceptual framework for aging-in-place in the neighborhood environment (Bigonnesse and Chaudhury, 2021)

Rigo (2022) states that elderly individuals prefer to reside in a terraced house with a spacious garden and balcony. Furthermore, there need to be communal areas and facilities within a 5-minute distance. However, the preferences differ per age group for example people aged above 70 value contact with others more than a large garden. Bigonnesse and Chaudhury (2021) confirm the various preferences among the elderly by stating that aging-in-place is not a one-size-fits-all concept, its realization varies across individuals and contexts, requiring flexible and innovative approaches.

## 2.2 | Living preferences of people aged 65 and above

According to Centraal Bureau voor Statistiek (2020) most people in the age group 65-75 years old live in non-senior terraced houses and the second most popular type of housing is a non-senior flat or apartment. Only 9% of this group lives in a senior dwelling. 57.5% of the 65-75 age group report that their toilet, bathroom, and bedroom can be accessed from the living room, but require the use of stairs. The accessibility of the toilet, bathroom, and bedroom from the living room without using stairs is an important criterion for determining if the dwelling is suitable for the elderly (Centraal bureau voor Statistiek, 2020; PBL, 2019). Furthermore, 46,5% of this age group is highly satisfied and 43,1% is satisfied with their dwelling. This also accounts for the living environment, where 37,5% are highly satisfied and 48,9% are satisfied with the living environment. That is also mainly the reason why 60% of this age group doesn't want to move, only if there is no other option according to Centraal bureau voor de Statistiek (2020). The elderly who mention that their dwelling is suitable for aging-in-place prefer to stay and adjust their dwelling. In the 65-75 age group, 40% of individuals with unsuitable homes for aging-in-place are unsure whether they prefer to make adjustments to their current dwelling or move. Additionally, 36.6% of this group prefers to adjust their current dwelling. Moreover, 8 out of 10 individuals aged 55 and above are interested in smart living features, such as systems that open and close curtains, to help them live longer in their current homes. The primary reasons for 65-75-year-old individuals wanting to move are health issues and having a dwelling that is too large. People with health issues prefer a rental home instead of buying a house. The age group 65-75 that wants to move prefers a flat or apartment. 63.4% of this age group prefers to live in a senior dwelling (Centraal Bureau voor Statistiek, 2020).

According to Ahli (2019) there is a need for small-scale houses with age-friendly features for elderly with a low to middle income. In The Netherlands, housing associations provide housing for the low-income group. Additionally, 35% of the tenant population in housing associations in The Netherlands is above 65 years old (Aedes, 2018). Moreover, the Dutch government expects housing associations to take the lead in the energy transition of the existing building stock, meaning housing associations need to renovate their building stock. Housing associations have a standard design dwelling which is not suited for aging-in-place. A third of individuals aged 65 and older report that their homes are not suitable for aging-in-place (Centraal Bureau voor Statistiek, 2020). While their preference is to stay in their current home for as long as possible and change their dwellings to be age-friendly. Moving is only considered when no other option is possible. However, the standard design dwelling in social housing results in the elderly having to relocate while their preference is to stay in their current dwellings.

## 2.3 | Dutch housing associations

The term social housing has different meanings in various countries, however, it has some dimensions that are similar in these various countries. Social housing broadly includes three major characteristics: First, it is given by landlords at a cost that is mostly set aside for non-profit reasons. Secondly, it is distributed administratively based on a preconceived notion of "need." Third, the government has broad and increasingly pervasive control over socially rented housing. There have been changes in relation to this final trait. Social rented housing is integrated into a publicly-controlled planned economy and forms the low-income housing sector (Boelhouwer, 2014). Dutch housing associations are non-profit organizations dedicated to offering affordable housing to individuals with low incomes (van Deursen, 2023a).



Housing associations operate within the social sector and act as social enterprises, addressing societal needs where the market falls short. Positioned between the public and private sectors, they employ a business model to deliver social services, subject to specific regulations and privileges. Housing associations have three roles, they act as landlords, developers, and asset managers. As landlords, they manage social rental units, attending to tenant requirements, property maintenance, and neighborhood upkeep. In their role as developers, they undertake new social housing projects financed through rental income surplus, unit sales, and low-interest, long-term loans. As asset managers, they oversee their extensive real estate holdings, identifying opportunities and needs that balance social impact with financial viability.

The primary social responsibility of housing associations is to provide affordable housing to low-income individuals, defined across four dimensions: affordability, availability, quality, and management. They are obligated to maintain rental rates at levels manageable for their tenants, while the government also plays a role by setting maximum rent thresholds of 879,66 euros per month in 2024 according to Ministerie van Binnenlandse Zaken en Koninkrijksrelaties (2024), limiting annual increases, and providing rental subsidies. Despite the maximum set by the government, most housing association rents are considerably lower, with the average social rent being €561 in 2021, requiring tenants to contribute around 33.8% of their income to rent. Housing associations are obligated to let 92.5% of their vacant social housing to people with an income of up to € 47,699 (one-person household) or € 52,671 (multi-person household) and no more than 7.5% to people with higher incomes than € 47,699 and € 52,671 respectively in 2024 (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2024). Ensuring availability involves fair allocation of social housing units through a transparent platform, as well as meeting the increasing demand by constructing new units, with plans to build 250,000 new social units by 2030 in response to rising demand (van Deursen, 2023a).

Quality assurance is another key aspect, with housing associations investing in ongoing maintenance of houses and immediate surroundings, such as alleyways and parking spaces, and high-quality construction, aligning financial and social interests due to the perpetual ownership assumption. Additionally, housing associations are expected to take the lead in the country's transition to carbon-neutral housing by retrofitting existing units for improved energy efficiency and adhering to high energy standards in new constructions. Another responsibility of the housing associations is building and letting social property, for example, schools and sports facilities. Furthermore, they are responsible for providing attentive property management, which involves negotiating with tenants' unions, connecting tenants with social services, and addressing the needs of vulnerable groups like the elderly, disabled individuals, and refugees (van Deursen, 2023a). Lastly, housing associations are responsible for appointing caretakers and neighborhood managers. The government intends to simplify legislation and promote collaboration among home care providers, housing associations, and other civil society organizations. They will then be able to plan their activities, such as customizing their services to offer care in senior homes (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2021). Klaveren, Räkers & Akkermans (2024) confirm the necessity of collaboration between housing associations, municipalities, and care organizations for living with tailored support, and define the role and tasks in this partnership, see Figure 7.



Organization	Role	Tasks
Housing associations	Landlord, manager	<ul style="list-style-type: none"> <li>• Building, managing, and renting (affordable) homes</li> <li>• Collaborating with municipalities and other parties on livable neighborhoods</li> <li>• Identifying (potential) issues</li> </ul>
Care organization	Provider of guidance (and organizing residence in the case of intramural facilities)	<ul style="list-style-type: none"> <li>• Guiding clients towards (optimal) independence, working on recovery and stability</li> <li>• Conducting case management</li> <li>• Assessing whether individuals can live independently (without causing disturbance)</li> <li>• Noting any changes in support needs</li> </ul>
Municipality	Director, purchaser, organizer of conditions	<ul style="list-style-type: none"> <li>• New construction programming</li> <li>• Housing regulations/urgency regulations</li> <li>• Negotiating (annual) performance agreements with housing corporations</li> <li>• Public mental health care procurement</li> <li>• Organizing and supporting a strong social foundation (welfare and freely accessible neighborhood facilities)</li> <li>• Investing in livability in neighborhoods and communities  </li> </ul>

Figure 7 | Separating housing and care: role and task distribution in the case of living with customized support (Klaveren et al., 2024)

Since its founding in the 1860s and the introduction of the Housing Act in 1901, the Dutch social housing market has undergone multiple changes. The Housing Act of 1901 regulates the construction of dwellings to ensure the improvement of living conditions and hygiene. Throughout the 20th century, housing associations were private organizations that experienced varied levels of government influence. The social housing sector emerged as a vital tool in the fight against housing shortages following World War II (Van Bortel & Elsinga, 2016). The housing shortage was a result of the rapid growth of households and low production of residential constructions. Many social rented dwellings were built cheaply and quickly resulting in the expansion of this sector. The Dutch government continued to be involved in the operation and financing of housing associations from 1945 until 1990. They consequently evolved into semi-public organizations with close hierarchical ties to the government. However, Dutch housing associations have turned into strong partners in local networks and have achieved financial independence since the 1990s (Van Bortel & Elsinga, 2016). The 1990s Memorandum on Housing places special focus on decentralization, self-sufficiency, and deregulation. One of the new policy lines is the decentralization of authority. Featured are the State's obligations and risks being transferred to local governments and provinces, as well as the autonomy of housing associations and consumer-run organizations. Between 2002 and 2007 very little was built because the national government stated new housing production should concentrate on the market sector. The financial position of housing associations is robust creating room for investments. The industry has a strongly unfavorable reputation; examples include excessive wages, arrogance, fraud, and historically low housing production. However, the public may think negatively of housing associations in practice they

were making a lot of socially acceptable investments (Boelhouwer, 2014; Van Bortel & Elsinga, 2016). In 2015 the government retained the social housing sector with the implementation of the Housing Act of 2015, including regulations introducing an income limit for the social housing tenants, a landlord levy, and separating the portfolio of housing associations in social and commercial activities. There have also been significant changes made to the management and oversight of the Dutch social rental market. There is now a new housing authority that is under the control of the national government. This body has tight oversight over the housing associations' operations, finances, and governance (Hoekstra, 2017). Today, housing associations are well-organized non-profits, professionalized, and financially healthy. Van Deursen (2023b) depicts this timeline and the position of the housing associations in the triangular diagram of social, public, private, see Figure 8.

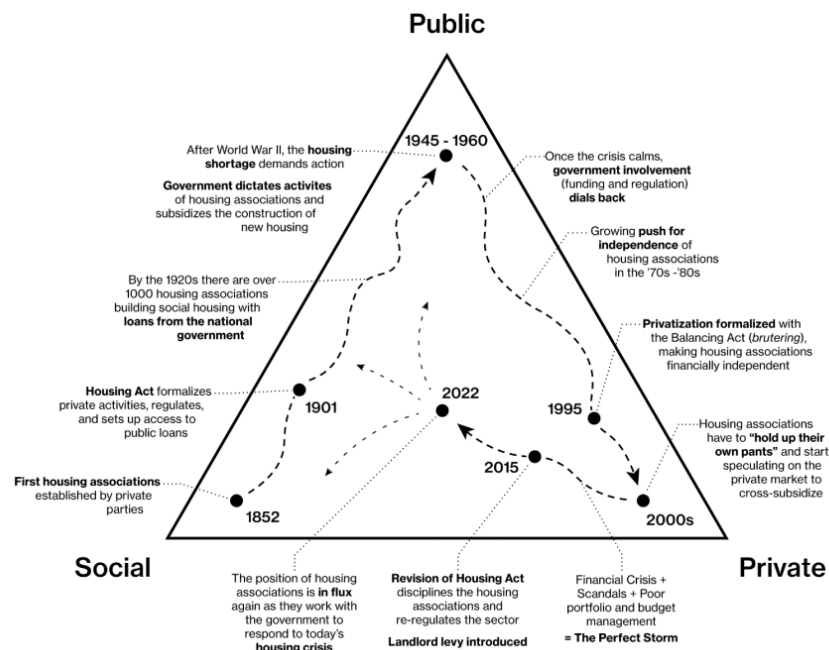


Figure 8 | Housing association change overtime (Deursen, 2023a)

Housing associations are mostly organized in three levels, the strategic level, tactical level, and operational level according to Aedes (2023). These three levels include three types of management, portfolio, asset and property management, see Figure 9. Portfolio management entails the development of the housing associations' building stock, including the size (growth, shrink, stabilized), composition (product-market combinations, rooms, type, target group), and quality (energy performance, floorplans, and accessibility). This leads to a transformation project that needs to be realized through new construction, renovation, demolition, buying, or selling. Asset management includes the translation of the portfolio strategies into strategies for the neighborhood and complexes. Property management executes the strategies formulated by asset management, maintenance plans, and policies. These different organizational levels are inextricably linked, since the strategies from the strategic level are specified more on the tactical level, and even more specified into execution plans on the operational level. Moreover, the operational level gives feedback to the tactical level which also adds feedback to the portfolio managers which takes this input into account when making new policies and strategies (Aedes, 2023).

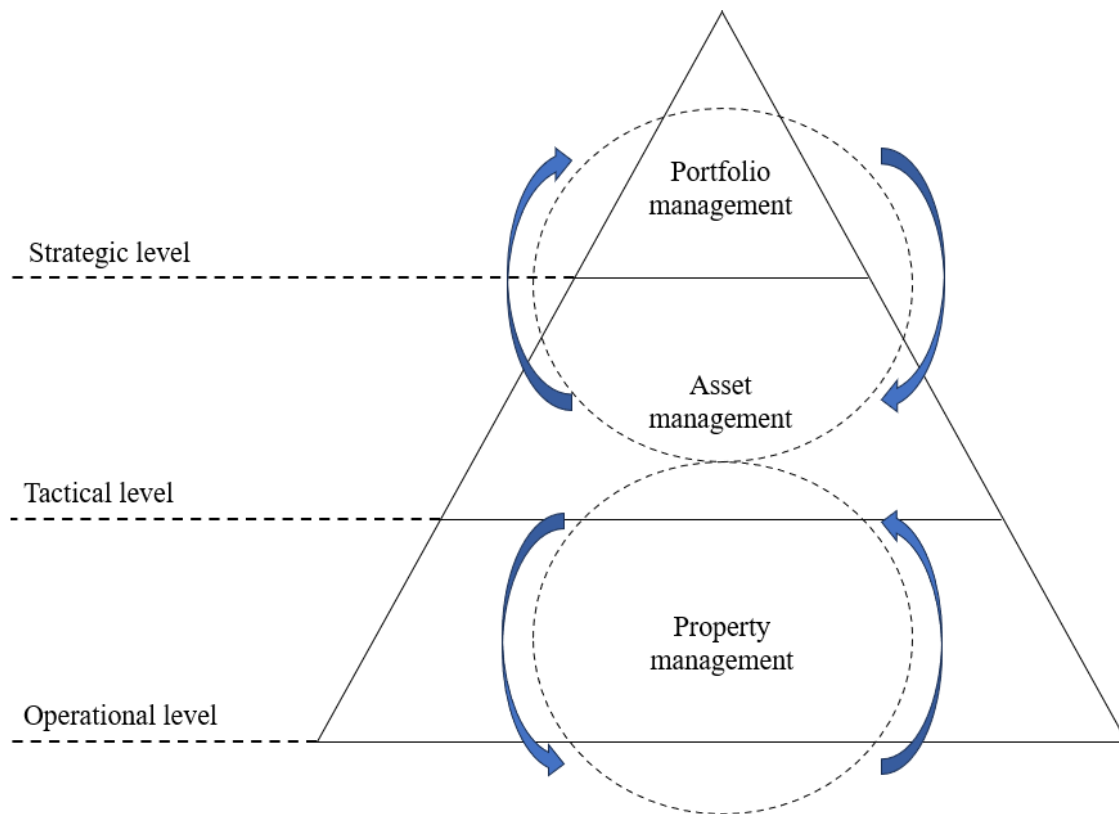


Figure 9 | Organizational levels and managements (Aedes, 2023)

As mentioned housing associations address the needs of vulnerable groups like the elderly. The aging population demands different forms of living, because people want to live longer at home. Healthcare needs to be provided in the homes of the elderly. There is increasing awareness that individuals with limited opportunities have a reduced life expectancy (Aedes, 2016; Leidelmeijer et al., 2017). Housing associations try to signal health issues and help with the housing of these people. Commitment is necessary for new collaborations between housing associations, healthcare organizations, and municipalities, to focus on the social problem (Aedes, 2016). Another challenge housing associations face is renovating their building stock to meet the energy requirements. Many of the buildings owned by housing associations in The Netherlands were built after the Second World War, and 80% of the social housing building stock needs to be replaced or renovated before 2040 (Aedes, 2016). The housing associations are expected to take the lead in the energy transition in the existing building stock due to their vast building stock with comparable houses (Ministerie van Economische Zaken en Klimaat, 2020).

## 2.4 | Energy renovations

Housing associations face multiple challenges in the energy transition. First, the housing associations need 70% approval of the tenants whose homes will be renovated. Second, the result of renovation not only has to meet the energy performances but also building, noise, architectural, and urban performances. These renovation costs can become as expensive as demolishing the dwellings and building new homes. Third, depending on the level of renovation tenants need to be relocated to different social houses. Fourth, energy norms get higher with time and there are many developments in the renewable energy sector making the investment decision more difficult (Aedes, 2023).

The characteristics of dwellings managed by non-profit housing associations in the Netherlands have shown slight changes over the years, including a small increase in the share of apartments and an average size increase of single dwellings by 2.0 m<sup>2</sup> according to Van Der Bent et al. (2021). Most buildings are constructed with heavy materials like concrete or bricks, with significant improvements in airtightness over the years. However, the degree of insulation remains relatively low, with a large portion of the housing stock having poor or no insulation, particularly in floors and facades. The dominant heating systems are condensing gas boilers, especially the condensing HR107 gas boiler, while more innovative heating systems are slowly gaining traction. Ventilation systems remain traditional, with a substantial portion of dwellings lacking any installed ventilation system. Solar PV panel adoption is increasing, but as of 2020, only 10.4% of dwellings have them, indicating significant potential for growth. Large housing associations, especially those with over 25,000 dwellings, are crucial for sector improvements, owning 35% of the non-profit housing stock and contributing 39% to sector progress. The provinces of Noord-Holland and Zuid-Holland, holding 45% of the non-profit housing stock, are key contributors, responsible for 49% of the sector's progress between 2017 and 2020 (Van Der Bent et al, 2021).

Most policy initiatives in the Netherlands are geared toward lowering energy consumption by raising building energy performance levels through enhanced energy labels. The EI, which is the relationship between the total heated floor area, the heating losses, and the modeled annual primary energy consumption, represents the energy performance of an existing building. The EI is classified using energy labels and normally ranges from 0, very good performance, to 4 very bad performance (Filippidou et al., 2018). An Energy Label, also referred to as an Energy Index, represents the theoretical energy consumption of a dwelling based on its building characteristics, compared to a building-specific budget. The energy labels range from A+++ to G, with A+++ indicating an energy-neutral building, where the dwelling generates as much energy as it consumes. Housing associations have an average energy label B (Van Der Bent, 2021).

The Netherlands has a standard that gives insight into when dwellings are insulated sufficiently enough to cut off the gas. The “standard” result from the Klimaatakkoord. There is a standard for the energy label calculated with a formula that includes the square meters of the dwelling, the square meters of the façade, and the square meters of the roof. Moreover, the standard is given per dwelling type and year of construction. This is because the age and type of the building have a significant impact on the need for renovations according to Filippidou et al. (2018). Apart from the standard for the energy label, there is also a target value for separate building parts which includes the thermal resistance value, ventilation, and sealing (RVO, 2021). On 1 January 2030, legal requirements will be imposed on the rental of housing association dwellings to guarantee that insufficiently insulated dwellings are improved to meet the standard.

Dwellings that are renovated to label A or B with a horizon of circa 25 years don't reach “the Standard”. Another implementation needs to be done to reach this level. Some housing associations choose to renovate in this manner because it allows the dwellings to be renovated to a satisfactory standard for the time being. This provides housing associations with the necessary time, given the uncertainties surrounding quality requirements and renewable energy, to make a final decision on the renovation plans for the dwellings. Another advantage is that renovation can take place without relocating tenants. Another strategy involves

renovating to the "Standard" through a single renovation project. Disadvantages are the high costs to insulate the building skin, new foundation and prepare the inside of the dwellings for renewable energy installations (Aedes, 2023).

## **2.5 | Barriers and opportunities**

Exploratory interviews and literature reveal various opportunities and barriers in integrating aging-in-place features in energy renovations.

The most emphasized opportunity in literature is the advancement of age-friendly systems, including improvements in technology such as e-health and domotics, which offer the promising potential to enhance the living conditions of older adults (PBL, 2019). These innovations can include features such as stairlifts for spiral staircases, making multi-story homes more accessible (Leidelmeijer et al., 2017). Apart from devices and innovative care technologies, the comfort and indoor climate of the homes also support aging-in-place. Improvements in comfort and indoor climate, such as standard dwelling insulation, contribute to a more pleasant and adaptable living space for aging individuals (RVO, 2021). Moreover, larger dwellings offer more flexibility in space usage and provide greater options for integrating age-friendly features at reasonable costs, thus allowing for the implementation of aging-in-place features. Universal design principles can further enhance this flexibility, allowing for the accommodation of multiple households within a single dwelling. Collaboration between municipalities, housing associations, and health services can foster the development of integrated solutions tailored to the needs of aging populations. This collaboration can lead to the introduction of new services, such as improved delivery options and accessible healthcare (PBL, 2019).

Apart from the opportunities to integrate aging-in-place features in energy renovation, literature also identifies barriers. Small one-family dwellings pose challenges for integrating age-friendly features, such as stairlift installations, due to limited space (Leidelmeijer et al., 2017). This limitation complicates efforts to retrofit these homes to meet the needs of aging occupants. Furthermore, collaboration between stakeholders, while essential for developing comprehensive solutions, can also present challenges in terms of coordination and alignment of priorities. Moreover, creating age-friendly neighborhoods involves considerations beyond individual dwellings, including the accessibility and suitability of the surrounding environment for aging residents (PBL, 2019). Housing associations may face resistance from elderly tenants who are reluctant to leave their current homes, even if they are unsuitable for aging-in-place. This reluctance can stem from emotional attachment, logistical concerns, or a preference for familiarity (ASR Dutch Core Residential Fund, n.d.). State regulations and agreements with municipalities can impose constraints on housing associations, limiting their ability to allocate resources and prioritize the needs of the aging population. Inefficiencies in healthcare services, such as the requirement for employees to travel between different buildings, can hinder the delivery of effective care to older adults. Housing associations may seek to consolidate healthcare services within their complexes, potentially limiting residents' choice and autonomy (explorative interview 2, housing association).

## 2.6 | Integrated theoretical framework

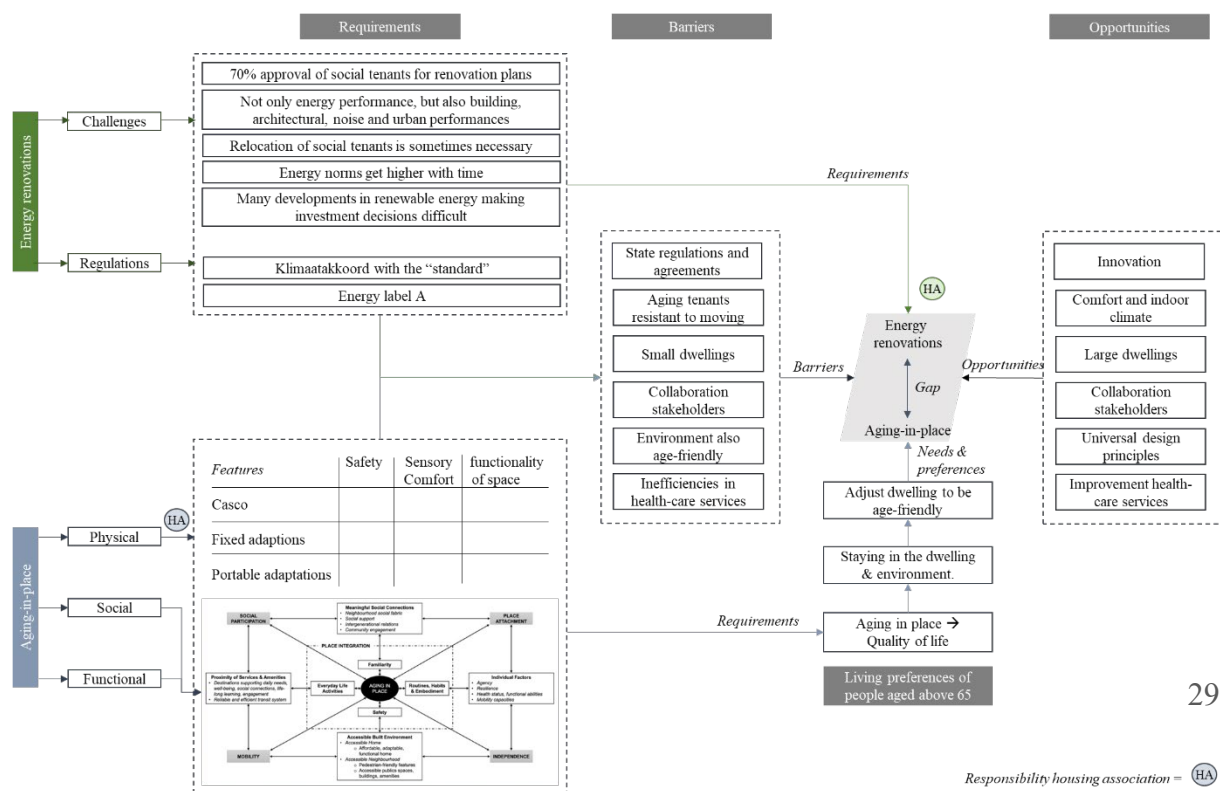
The integrated theoretical framework for this research on integrating aging-in-place features into energy renovation projects combines insights from multiple disciplines to address the interconnected challenges of an aging population and climate change. The two core concepts, energy renovations and aging-in-place, each have their own requirements as specified by the literature.

Aging-in-place refers to the ability of individuals to age in the home of their choosing, encompassing both the dwelling (physical aspect) and the environment (social and functional aspects), which need to be age-friendly. The physical aspects are the responsibility of the housing association. Improving these aspects to facilitate aging-in-place has a positive impact on the quality of life of the elderly. Moreover, individuals aged 65 and above often prefer to stay in their current dwellings and have them renovated to be age-friendly. These requirements, needs, and preferences are essential inputs for aging-in-place initiatives.

Energy renovations involve making buildings more energy-efficient to reduce greenhouse gas emissions and promote sustainability. This poses multiple challenges. Housing associations are expected to take the lead in the energy transition, guided and restricted by government regulations. These challenges and regulations create specific requirements for energy renovations.

Integrating these two core concepts encounters multiple barriers. These barriers must be addressed to advance the energy transition of the existing building stock while meeting the needs of the aging population. The literature identifies several opportunities for integrating these concepts, offering inspiration and insights into overcoming the barriers.

By combining insights from various disciplines, this framework aims to provide a comprehensive understanding of how to integrate aging-in-place features into energy renovation projects. Addressing the barriers and leveraging the opportunities identified in the literature can help housing associations and other stakeholders create age-friendly, energy-efficient homes, thereby improving the quality of life for the elderly and promoting sustainability.





# Chapter 3 | Research method

3.1 | Research context

3.2 | Research design & data collection

3.3 | Data analysis





### 3 | Research method

#### 3.1 | Research context

This study uses the case of a Dutch social housing association since the government expects them to take the lead in the energy transition due to their vast building stock with comparable houses. Additionally, housing associations have a tenant population that included 35% of people aged above 65 years old (Aedes, 2018). Their primary responsibility is to provide affordable housing to low-income individuals (van Deursen, 2023a). This study focuses on terraced houses since the building stock of The Netherlands consists of 42% terraced homes, thus this typology is the most common (Centraal Bureau voor de Statistiek, 2023b). The quality and performance of the residential stock are greatly impacted by the large number of post-war terraced houses that were constructed. These houses continue to be a major energy consumer (Greco et al., 2017). According to the Centraal Bureau voor de Statistiek (2020), the majority of people aged 65-75 live in non-senior terraced houses. Moreover, there is tension in the renovation process for these houses with the elderly, because the housing association wants the elderly to move out to make room for other target groups, whilst the elderly prefer to stay in their current dwellings (ASR Dutch Core Residential Fund, n.d.). Interviewee 3, portfolio manager of a housing association, confirms this *“When new buildings or apartments that are suitable for seniors become available we actively approach single households and elderly that live in relatively large single-family dwellings”*. Additionally, there are many physical barriers, for example, the stairs, to improve the age-friendliness of the terraced houses. For this reason, this thesis focuses on terraced houses.

This study encompasses physical, social, and functional aspects to take a holistic approach. Not only the homes but also the neighborhood has to be age-friendly for the elderly to be able to live independently at home (Wilhelmson et al., 2005; PBL, 2019). Thus, interview questions will not only focus on the physical factors, but will also focus on social and functional factors. Therefore, the perspectives of municipalities and healthcare providers are included in the research. The research context is depicted in Figure 11.

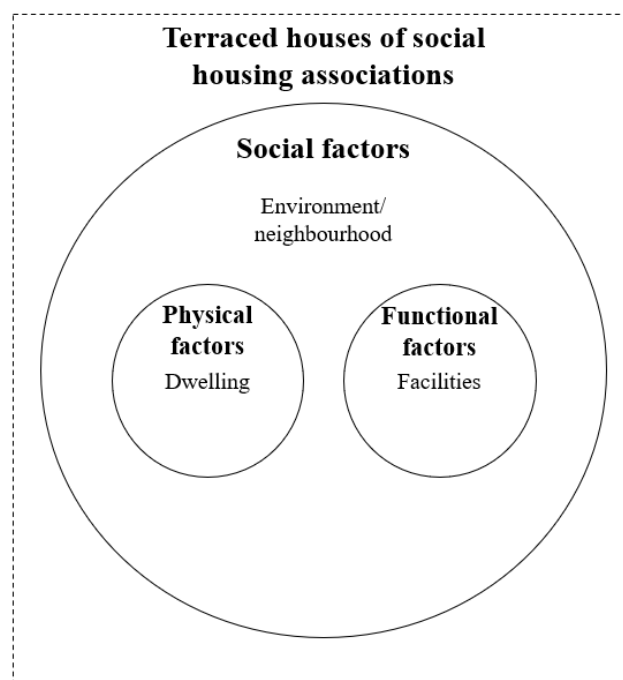


Figure 11 | Research context (own figure)

Literature shows that older people are defined as humans with a chronological age of 65 years old or older (European Union, 2022; Orimo et al., 2006). According to the Centraal Bureau voor de Statistiek (2015), more elderly people are living independently at home and the number of elderly in nursing homes is decreasing. Ninety-five percent of people aged 65 and older live at home. Two-thirds of the elderly that live at home don't experience disabilities in every day activities. Furthermore, 75% of individuals in this group rate their health as good or very good. However, as people age, they experience more disabilities. In the age group 65-74, 11% have at least one Activity of Daily Living (ADL) disability and 18% have an Instrumental Activity of Daily Living (IADL) disability. For those aged 75 and older, these percentages increase to 31% and 44%, respectively, which is significantly higher compared to the 65-74 age group. ADL and IADL are both measurement tools that evaluate limitations in daily activities due to health issues. This does not concern temporary problems (Centraal Bureau voor de Statistiek, 2015). This study focuses on individuals aged 65 and above, as disabilities in everyday activities tend to increase in this age group.

### 3.2 | Research design & data collection

The research design is presented in Figure 12. It categorizes the opportunities and barriers to integrating aging-in-place improvements in energy renovations across strategic, tactical, and operational levels within an organization. After this, the preferences and needs of aging social tenants are identified through the exploration of sub-research question 2. These identified demands are important considerations for formulating strategies aimed at overcoming barriers. Furthermore, insights obtained from initiatives related to the integration of aging-in-place improvements in energy renovations offer valuable lessons on effective strategies in practice. The findings from sub-research questions one through three serve as the foundational input for formulating strategic recommendations on overcoming barriers associated with integrating aging-in-place features in energy renovations of social housing in The Netherlands.

This study employs multiple research methods. Interviews are conducted to address all the research questions. Additionally, a quantitative analysis is executed to generalize the needs and preferences of aging social tenants. Sub-research three utilizes two case studies.

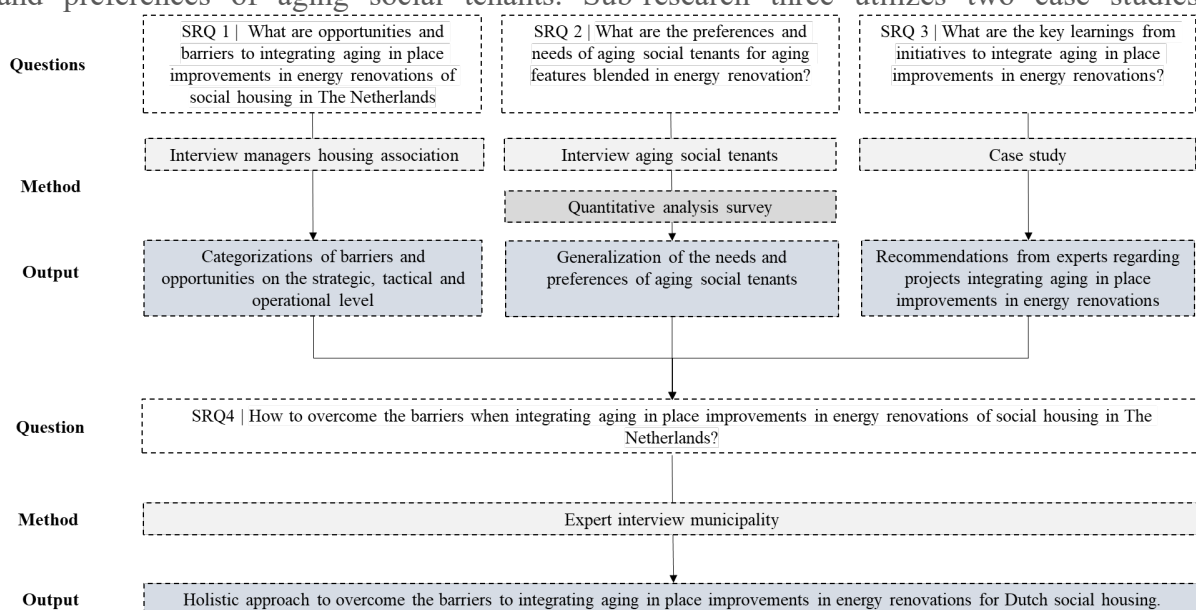


Figure 12 | Research design (own figure)

Through an inductive approach, this study adopts qualitative and quantitative research methods. The inductive approach allows for the analysis of a specific reality after this a probable generalization or explanation is derived from this reality (Hoekstra, 2022a). This embedded mixed-method research design gives a more comprehensive understanding. The strengths of one type of data, the qualitative and quantitative data, often compensate for the weaknesses of the other. The research benefits from the detailed, contextualized qualitative data and the generalizability, externally valid insight of quantitative data. The embedded design collects and analyzes both types of data at the same time, however within a larger qualitative research (Amaratunga et al., 2002). The quantitative data is secondary to the primary qualitative data. The embedded design strengthens the conclusions of the qualitative research results with the quantitative data, enhancing the credibility of the results. The qualitative data is generated through in-depth interviews and case studies, allowing for more detailed and contextualized data, for example, interviews can ask follow-up questions. These methods are limited by the small sample size and don't allow for generalization. The quantitative data is secondary data from a survey with a large sample size, which allows for the generalization of the findings and validation of the primary qualitative data, enhancing the credibility of the research. This approach is particularly valuable in complex research where both broad trends and personal experiences, such as the energy transition and the preferences and needs of aging social tenants, are important for comprehensive insights (Amaratunga et al., 2002; Hoekstra, 2022a).

The data collected from the empirical research through in-depth interviews and case studies is primary data. The data collected from the literature research and the survey are secondary data. Secondary data is data that is collected by other researchers and primary data is collected by the researcher him or herself. The secondary data is gathered from Google Scholar, Dutch research organizations, TU Delft Library, and other scientific journals. The interviews are semi-structured, in which the general structure of the interview is fixed and allows the interviewer to ask follow-up questions to get better insights. The audio-recorded interviews are transcribed and imported into Atlas.ti where the interviews are coded. The transcripts will be coded with first-order codes and second-order themes.

### **SRQ 1 | Barriers and opportunities**

First, the current reality is analyzed by researching the barriers and opportunities to integrating aging-in-place improvements in energy renovation through in-depth interviews. Choosing in-depth interviews gives in-depth insights into the expert's perspective, motivations, beliefs, decisions, emotions, and personal stories. Only using in-depth interviews may result in biases because respondents may offer socially desirable answers (Hoekstra, 2022b). Therefore, this study uses a combination of different methods to collect data about integrating aging-in-place improvement in energy renovations, including a literature study, in-depth recorded (expert) interviews, case studies, and quantitative analysis.

The housing association is selected through purposeful sampling. The selected social housing association Alpha owns 51.018 social rented dwellings in 2021, of which 33,5% are single-family dwellings and 42,% multi-family dwellings without an elevator. Additionally, the portfolio includes 230 elderly homes and 19.928 single-story houses. Alpha notices a decrease in the amount of single-story houses in their portfolio between 2011-2014. Whilst a third of the tenant population of Alpha is aged 65 or older. Now Alpha constructs new dwellings with



aging-in-place features. Most of the houses were built between 1980-1989, and a sixth after the Second World War. Most of these dwellings don't meet the energy requirements set by the government.

The theoretical background shows that housing associations are organized in three different levels, strategic, tactical, and operational, in which management can encounter different opportunities and barriers. Therefore, this study interviewed a portfolio manager, asset manager, and property manager to get a comprehensive understanding of all the barriers and opportunities on the various levels within a housing association. Within the selected housing association, two tactical and operational managers are interviewed. Additionally, an ex-portfolio manager, external to Alpha, is interviewed to identify barriers and opportunities on the strategic level.

## **SRQ 2 | Preferences and needs aging social tenants**

Second, aging social tenants from the same housing association were identified through snowball sampling. The operational manager is frequently in contact with aging social tenants, who provided participants for this study. This included a single woman and a couple, both approximately 70 years old, who had undergone a renovation project in their terraced houses. Interviews were also conducted with aging social tenants renting from a different housing association to ensure a comprehensive understanding. In this group, two single women, currently residing in temporary accommodations due to home renovations were interviewed. The interviews provided detailed insights into the needs and preferences of the participants. This method allows for follow-up questions, clarification of unclear questions, and for interviewees to explain the reasoning behind their answers. However, these results are not generalizable. Therefore, quantitative survey results from Woonbond (2021) are analyzed. This quantitative research conducted by Woonbond in collaboration with Saint-Gobain studies the experience of social tenants in renovated dwellings. In theory, energy renovation projects lead to energy saving and improved well-being (a comfortable, healthy, and safe home) for residents, but whether this is achieved is unclear. To find the answer to this question, Woonbond and Saint-Gobain surveyed 689 respondents living in a renovated social house. A descriptive analysis of the survey results will give insights into the needs and preferences of aging social tenants regarding their home and renovation improvements. The quantitative research results are compared with the qualitative results to see whether they support or contradict each other, and if generalization is possible.

## **SRQ 3 | Key learnings**

Third, resulting from the first research question is the concept of splitting dwellings as an opportunity to age in place. To learn more about this concept and the key takeaways from practice a housing association that adopts this concept is selected. To ensure a comprehensive understanding, a different case is also studied and selected through purposeful sampling. For this case study, an expert interview is conducted with a housing and care provider to include another perspective on the complexity of integrating aging-in-place improvements in energy renovations. The case provides new insights into implementing innovative care technologies in renovation projects. It offers a different perspective from the elderly care provider who deals with the challenges posed by the aging population. This insight is complementary to the research. Delta observes the needs, requirements, and methods of care for older social tenants daily. This presents opportunities and barriers in integrating aging-in-place improvements in

renovation projects, as well as new perspectives on the preferences and needs of these individuals. The cases are selected based on the case selection criteria in Figure 13. This study focuses on Dutch social housing, therefore the case needs to include social houses located in The Netherlands from Dutch organizations. Furthermore, the case needs to be a renovation project because this research includes only renovation projects of social housing, and this process has different challenges compared to new construction projects. Lastly, the case must improve the suitability for aging-in-place of a dwelling.

Case selection criteria	Case 1: Splitting dwellings (Gamma)	Case 2: Studios to Senior Apartments (Delta)
1. Dutch organization that provides social housing in The Netherlands	Housing association with social houses for the elderly in South Holland	Housing and elderly care provider in Friesland
2. Renovation project	Renovating one dwelling into two dwellings	Renovating senior studios into senior apartments
3. Housing improvements for aging-in-place	Aging-in-place improvements in the renovated dwellings	Apartments are designed for the elderly including care technologies

Figure 13 | Case selection criteria (own figure)

#### SRQ 4 | How to overcome the barriers

Lastly, an expert is selected for an interview through expert sampling, to validate the strategy based on the empirical research results. This expert currently works for the municipality and has previous experience as a portfolio manager of a housing association and director of a platform providing information on aging-in-place. Thus, this expert adds a different perspective to the subject, as an employee of the municipality compared to the other interviewees, resulting in a more thorough understanding and holistic view including the physical, social, and functional aspects of aging-in-place. The interviews are held in Dutch to allow the interviewees to express themselves better and provide more information in their mother language. Figure 14 gives an overview of the conducted interviews per sub-research question.

Research question	Interviewee	Organisation	Organisational level	Role
SRQ1: Barriers and opportunities	Interviewee 4	Housing association: Alpha	Tactical level	Urban developer
	Interviewee 5	Housing association: Alpha	Operational level	Social management and living coach
	Interviewee 8	Municipality: Epsilon	Strategic level	Team manager Social Support
SRQ2: Preferences and needs of aging social tenants	Interviewee A	Housing association: Beta		Aging social tenant
	Interviewee B	Housing association: Beta		Aging social tenant
	Interviewee C	Housing association: Alpha		Aging social tenant
	Interviewee D.M, D.F	Housing association: Alpha		Aging social tenant
SRQ3: Key learnings from initiatives	Interviewee 6	Housing association: Gamma	Strategic level	Real estate manager
	Interviewee 7	Living and care provider: Delta	Strategic level	Real estate consultant
SRQ4: How to overcome the barriers	Interviewee 8	Municipality: Epsilon	Strategic level	Team manager Social Support

Figure 14 | Overview interviews (own figure)

### 3.3 | Data analysis

The empirical data is analyzed through open coding. Figure 15 shows the formulated codes with exemplifying quotes, for all the conducted interviews.

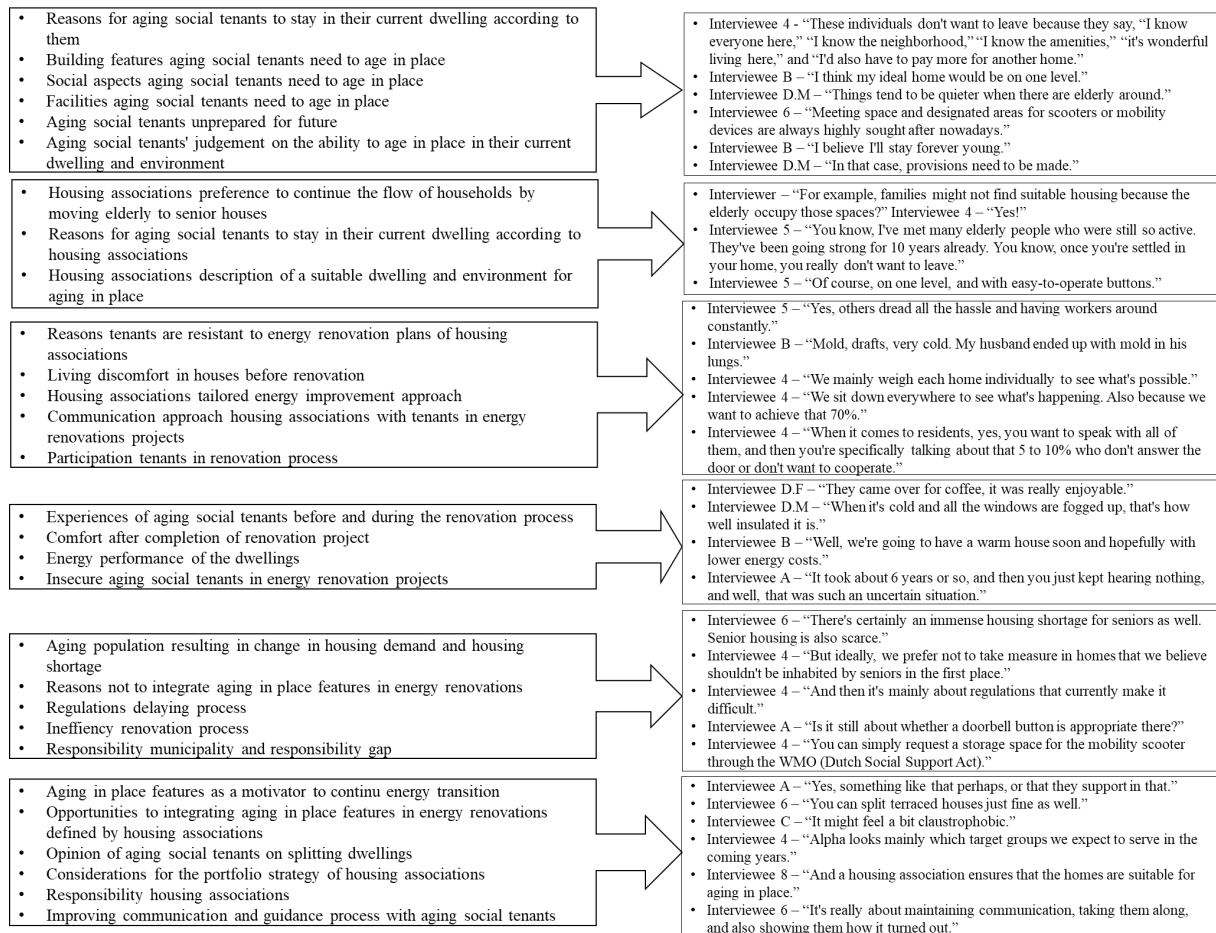


Figure 15 | Codes and exemplifying quotes (own figure) based on Gioia et al. (2013)

The analysis starts with identifying the first-order code. After this, the second-order themes are identified. Lastly, the aggregate dimensions can be found to provide new theoretical insights (Gioia et al, 2013). This is presented in Figure 16.

Results show that the demand of the aging social tenants conflicts with the demand of housing associations regarding aging-in-place. These results are explained in the results of research question 1. Moreover, new insights arose, through this coding method, namely about the process response to energy renovations from the perspective of housing associations and aging social tenants. This process response is further explored in the results chapter of research question 2. Lastly, the barriers and opportunities identified from the perspective of housing associations, municipality, and house and care providers, gave new insights to make a strategy to overcome the barriers. This is further explained in the results of research question 4.



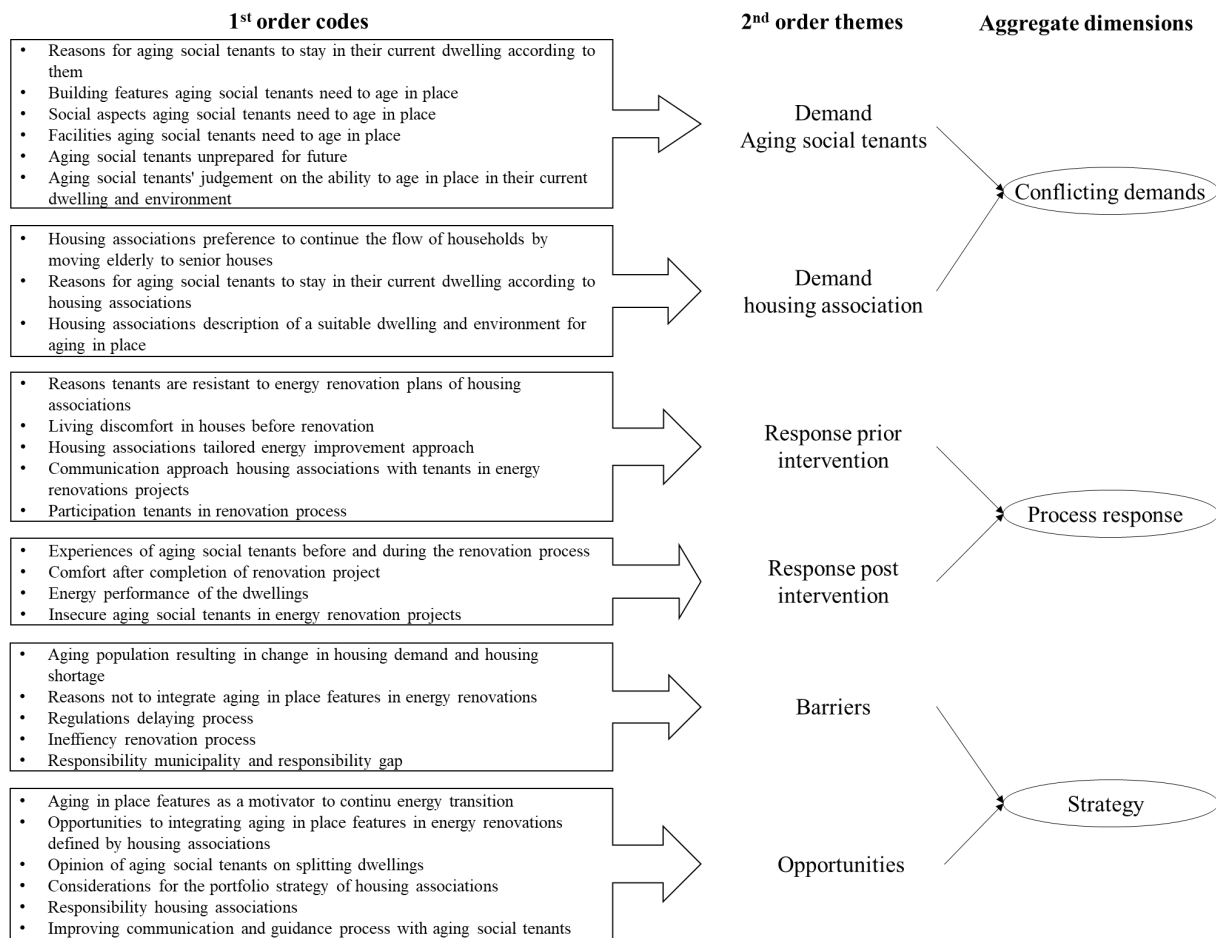


Figure 16 | First-order codes, second-theme codes, and aggregated dimensions (own figure) based on Gioia et al. (2013)

### 3.4 | Data plan and ethical considerations

The data management plan is added in the appendix created using DMPonline. This plan includes how the data is collected, stored, published and to whom the data is available, etc. The human research ethics checklist is also added in the appendix, which includes a risk assessment and mitigation plan.

The data collected is anonymous and is only collected after the respondents give written consent. This is to make sure not to cross the boundaries and privacy of the participants. The participants and respondents are numbered to ensure anonymity and will stay anonymous even after publishing the paper. Before data is collected from companies there is an agreement of the data of ownership and access control. Furthermore, only required data that is relevant to answering the research question is collected. Therefore, every week the research process will be evaluated to see if the research is still valid and that the required data is being collected. During the research, the data is only accessible to the researcher and assigned mentors Angela Greco and Queena Qian. The data is stored on my personal TU Delft Onedrive. To mitigate the risk of losing data a backup is stored on an external hard drive.

For the privacy of the participants of the interviews, the invitations are sent by e-mail, this way no one else can see that they have been asked for participation. Furthermore, participants have the option to voluntarily contribute to the research. The interviews are held at the office of the housing associations and the aging social tenants are interviewed in their own homes. The information collected is limited to what is essential for the research purpose. The

participants provided written consent and were informed about the storage, security, and anonymity of their information during and after the research. Moreover, the risks of participating are also outlined. The participants will stay anonymous by giving each participant a number, their names will never be published. Furthermore, personal information that is not required for the research is not asked, such as names, identity numbers, incomes, etc. The only personal information needed for this research is an e-mail address and their function within the company. This data is only available to the researcher and mentors. After publishing the research the personal data will be deleted. It is not suspected that the data can harm the participants. When this does happen, the data will not be published and the situation will be discussed with the participant and mentors Angela Greco and Queena Qian.



# Chapter 4 | Empirical results

## 4.1 | Barriers & opportunities





## 4 | Empirical research

### 4.1 | Barriers and opportunities

*What are the opportunities and barriers to integrating aging-in-place improvements in energy renovations of social housing in The Netherlands*

#### 4.1.1 | Barriers

Multiple barriers are identified in the interview results when integrating aging-in-place features in energy renovations. Housing association Alpha deals with the challenges of the aging population. Alpha's tenant population is aging and noticed that people aged 65 and above need to live longer independently at home. Noticeably, the aging tenants live longer and are healthier, leading them to prefer remaining in their current dwelling for extended periods. Whilst, the housing association prefers that the aging tenants in single-family homes move to single-story houses. They reason that the single-family houses are too big and unsuitable for aging tenants. Therefore, housing associations want the aging tenants to move out to more suitable dwellings and make room for other types of households such as families. A suitable dwelling for aging-in-place is defined by housing association Alpha as a single-story house with no steps, in which the turning radius for wheelchairs and walkers must be present, wide doorways, and easy-to-operate buttons such as automatic door opening. It is argued that the dwellings can have two floors but stairs should be wide enough in case a stairlift needs to be implemented. Figure 17 illustrates the building features identified by the managers as necessary for aging in place. Notably, while the managers proposed several functional space improvements, they mentioned relatively few comfort enhancements specifically tailored for aging in place. All managers stressed that an age-friendly dwelling is crucial, but equally important are the surrounding environment, facilities, and social activities.

Dimensions <i>Feng et al. (2018)</i>			
	<i>Personal safety</i>	<i>Sensory comfort</i>	<i>Functionality of spaces</i>
Degrees <i>Lorkeers et al. (2021)</i>	<i>Casco</i>	No steps (4,5,8) Electrical sockets, HVAC control, and switches fixed at sitting height (8) Automatic door opening (5)	Ventilation system (4)
	<i>Fixed adaptations</i>		Wide doorways and stairs (4,5,8) Turning radius (4,5,8) Single-story dwelling (4,5) Extra bedroom or spare room (4) Mobility scooter parking (4, 5) Toilet near bedroom (4)
	<i>Portable home adaptations</i>	Grab bars, handrails, and vertical bars in the bathroom (4,8) Medicine dispenser (8) Lights on bedside (8)	Raised toilet (4, 8) Sliding doors (4)  Stairlift (5)

Aging in place features in dwellings according to managers of housing associations

4 = Interviewee 4 addressed the feature

5 = Interviewee 5 addressed the feature

8 = Interviewee 8 addressed the feature

*Figure 17 | Managers' of housing associations' opinions on which building features are important for aging-in-place (own figure based on Feng et al. (2018) and Lorkeers et al. (2021))*



Furthermore, the unsuitability differs per age group and household, an example was given, it is not necessary for two vital aging partners with children to move out of their single-family house. In contrast with the preferences of Alpha, the aging tenants prefer to stay in their current single-family houses. The most common reasons for this are the rent increase and their attachment to the environment. Other aspects that also influence their preferences are their vitality, unawareness of their needs for aging-in-place, and if they have partner or not. This is exemplified by the following quote.

---

*Interviewee 4 – “Those people don't want to leave because they say, “Yeah, I know everyone here”, “I know the neighborhood”, “I know the facilities”, “It's fantastic living here”, and “I'd also have to pay more for another house.”*

---

Not only are the tenants resistant to moving, but they are also resistant to renovation plans. The most common reason for this is the discomfort during the execution phase and the potential rent price increase after completion. The aging social tenants were worried about the inconvenience of constant construction, mess, and activities in and around their homes during the renovation project. The following quote highlights this finding.

---

*Interviewee 4 – “They understand that it needs to happen, but they have this feeling, it's like, this is to try out, despite it being a relatively proven technique, they're like, why should we be the guinea pigs then? And then they also have this other feeling. Yeah, then my house will be turned upside down and so then I'm like, well, in 10 years, 15 years, I won't be here anymore, so I'll just tough it out.”*

---

A motivator for aging tenants to participate in the energy renovations could be the implementation of aging-in-place features. However, Alpha mentions it is not logical to implement aging-in-place features in single-family dwellings because; first these dwellings are not suitable for the elderly, second, there are physical barriers to implementing aging-in-place features in these dwellings, lastly, the expenses for the implementation is too high. This is exemplified by the following quote:

---

*Interviewee 4 – “It's not logical to make structural adjustments to those single-family homes to make them suitable for the elderly. Because they are not suitable homes. So, ideally, when you provide facilities for the elderly, you want to do it in homes that are designed to be age-friendly. And yes, in those homes, you simply implement measures for people who may become less mobile or are already so. Yes, so we do take those measures. But preferably, we don't do that in homes that we believe shouldn't be occupied by the elderly in the first place.”*

---

In contrast, interviewee 8 doesn't agree and argues that aging-in-place features should in standard be implemented in renovation projects including terraced houses, to have a universal design able to house multiple age groups. It is discussed that in standard implementations such as, the width of the doors being wheelchair-accessible, turning radius for wheelchairs and walkers, power outlets positioned at seated height for easy access, toilets that are slightly higher, and handle rails, should be integrated in energy renovations. This shows that housing associations have different ambition levels and take different positions in this social and technical issue. Therefore, these different opinions on whether to incorporate aging-in-place features in renovations arise.

Related to this is how responsible the various parties feel in this issue. In practice, there is a responsibility gap between housing associations, municipalities, healthcare insurance companies, and care providers. Tenants are being passed around between these parties because no one feels ownership. In the pilot of splitting dwellings, this issue arises.

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*Interviewee 5 – “While we're conducting that pilot, you notice that discussions arise about who, where can those two households go to when something goes wrong, or who will guide them, do they need guidance? Where does that role lie? And then the healthcare provider says, “yes, we are from healthcare,” and we say, “but we divide the homes and rent out the property,” and then a bit of a gap arises.”*

---

#### **4.1.2 | Opportunities**

There are opportunities identified in dealing with the tension between energy renovations and aging-in-place. First, the concept of splitting single-family houses is introduced, which is in the pilot phase for Alpha. This concept addresses the needs of aging social tenants and the demand for smaller houses for single households, due to the growing population of one-person households. Furthermore, energy improvements can be implemented in this renovation. The ground floor will be designated for aging tenants and the first floor tenants will be selected. The ground floor dwelling will have aging-in-place features such as a sliding door in the bedroom, the toilet close to the bed, the turning radius for wheelchair and walker use, and handles for the toilet. It also argued that it is not necessary to adjust the dwelling but the elderly can rent out a spare room. Additionally, splitting the dwelling results in the aging tenants being able to stay in the current dwelling, plus gives multiple social and functional benefits. This is exemplified by the following quote.

---

*Interviewee 5 – “That we split in two single-family homes, in which seniors would live downstairs. And perhaps the younger residents living upstairs could help the elderly. But I think the best option is that people can stay in the same neighborhood, and I think there is a need for that.”*

---

It is emphasized that regulations and permit procedures by the municipality delay the process for this concept. The technical plans for the building are approved easily by the municipality, however the parking regulations delay the process. The following quote supports this finding.

*Interviewee 5 - "In those neighborhoods where this is happening now, there's also a parking problem, so we had to wait for a year before we could proceed until that parking issue was resolved."*

Not only should the building features be age-friendly, as this concept focuses on, but the environment should be considered too. It is argued that the perspective and focus on “the dwelling” should be shifted to “living” by interviewee 8. For this, collaboration between municipalities, housing associations, and care providers is necessary. It is argued that the minimum housing associations can do is implement aging-in-place improvements in renovation projects. However, depending on the ambition level, an extra step can be taken to collaborate with municipalities, insurance companies, and care providers to ensure the environment is suitable for aging-in-place too. The social and functional factors in the environment that are considered for aging-in-place are presented in Figure 18. Additionally, housing associations should define what kind of housing association they want to be and which position they take in these social and environmental issues. The direction that a management sets in terms of vision, regarding energy transition and aging-in-place, is important

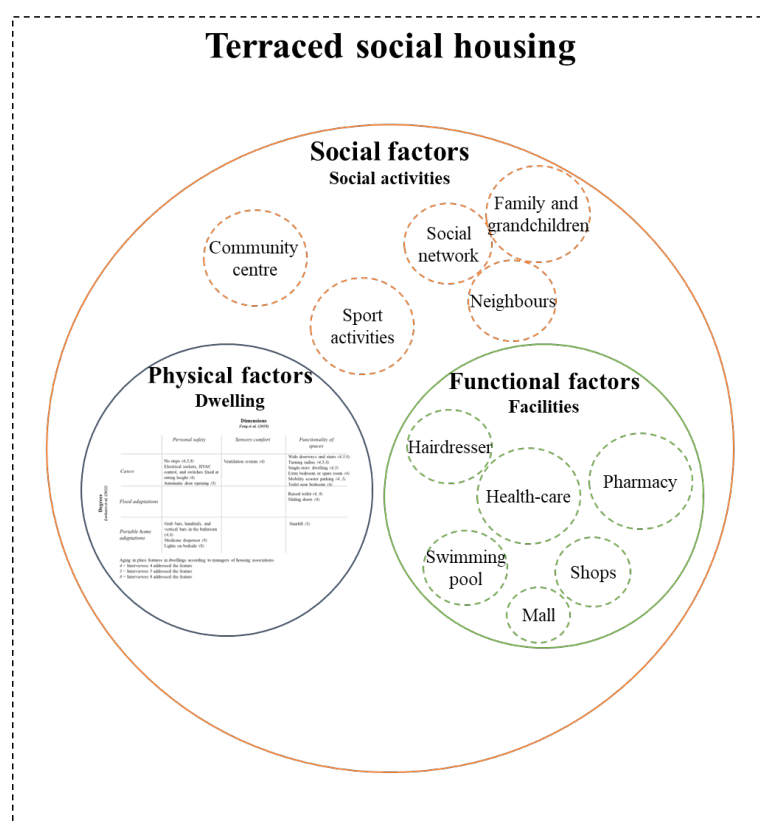


Figure 18 | Social and functional aspects for aging-in-place suggested by the property, asset, and portfolio manager (own figure)

Apart from collaborating with the municipality, insurance companies, and care providers, housing associations should also partner with market parties to contribute to innovation. Energy transition and aging-in-place are innovative issues. An opportunity is to shift the innovation costs, which are often initially very high, to be carried by the market, within agreements. Providing the market, the contractor, and the developer with the perspective that successful innovation can also be implemented on a larger scale. It is argued that courage and ambition are essential for all parties involved to take the first step and innovate. Currently, this is not the case, for example, even though the municipality is a member of a platform that provides aiding tools for aging-in-place, the municipality still didn't make use of the inspiration and tools to help solve the social issues. An example was given.

---

*Interviewee 8 – “We see, for instance, in the procurement and tendering of care that the municipality does not focus on innovative solutions. For example, you have a medication dispenser, which can easily be placed in someone's home for them to take medication every few hours. Well, someone still comes by for that.”*

---

Using innovative solutions can also be used as an opportunity to have more time with aging social tenants to socialize. It is mentioned that this aspect is now completely removed in the home and care services.

The managers of Alpha mention that expenses are a barrier to integrating the aging-in-place features in the energy renovations. In response to this, interviewee 8 counterargues that housing associations perceive it as expensive, but the actual costs for making small adjustments are not high.

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*Interviewee 8 – “You can easily create lighting near your bed with LED lights from the Action store that cost just a few euros, making it easier to navigate to the bathroom at night. That's very simple. But people still perceive it as expensive.”*

---

This means that changing the association of implementing aging-in-place features as expensive, can be an opportunity to motivate housing associations to start implementing these features in energy renovations.

It is argued that aging social tenants start thinking about the aging-in-place features they need when they start to experience disabilities in everyday activities due to health issues. An opportunity to prepare these tenants for the future is a living coach. The living coach starts a conversation with the elderly to get the tenants to think about their future and their options. Housing associations have a waiting list for senior dwellings due to the housing shortage. Important for the elderly is to sign up to increase the chance of getting priority for a house. Issues arise when the elderly start noticing disabilities but have to wait a couple of years before being able to reside in a senior dwelling. The housing association has a new tool where elderly people with urgency get priority. Apart from signing up, the elderly must become



aware of the fact that they might need extra features and support to be prepared for the future. The importance of informing and guiding aging social tenants with information about aging-in-place and future possibilities is emphasized by the interviewees.

Not only is communication and guidance necessary in this case but also for renovation projects. Aging social tenants are resistant to energy renovations. Tailored communication and guidance can minimize the resistance, which results from the experiences in practice. The perception of renovating, that it's complicated and discomforting, needs to change with extra guidance and communication efforts to unburden tenants.

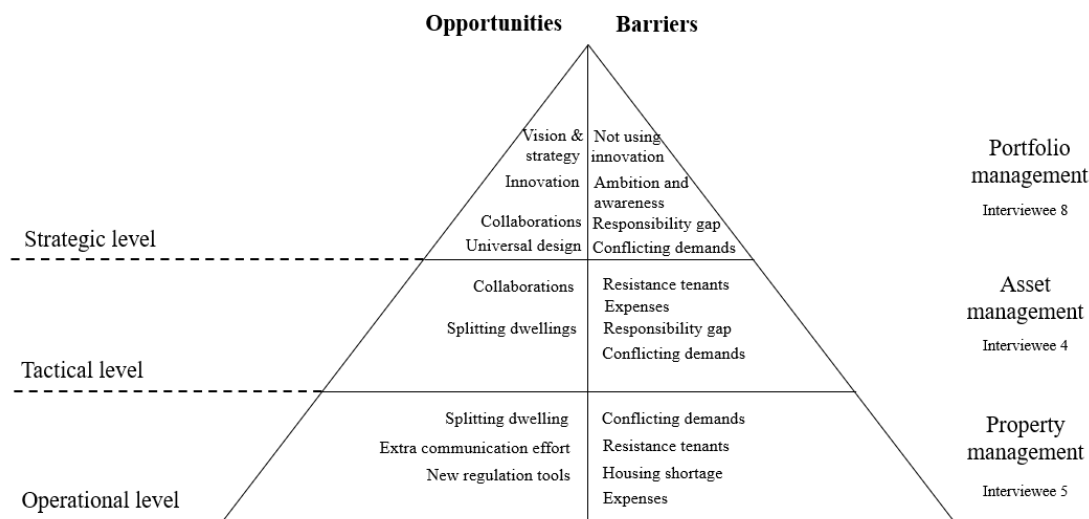



Figure 19 | Opportunities and barriers on the various organizational levels (own figure)

Figure 20 provides an overview of the insights directly or indirectly addressed by the three interviewees. Based on the integrated theoretical framework, the interviewees were asked to identify barriers and opportunities when integrating aging-in-place features into energy renovations. Additionally, the interviewees were asked to describe a suitable dwelling for aging in place, considering the physical, social, and functional aspects. For the topic of energy renovations, the interviewees were questioned about the process regarding communication and participation with aging social tenants, the dwelling quality before and after renovation, feedback from aging social tenants, and the energy performance of the dwellings. According to the integrated theoretical framework, these four inputs are essential for addressing the gap in integrating aging-in-place features into energy renovations of Dutch social housing.

2nd order Theme	Insights	Interviewees		
		5	6	8
Demand aging social tenants	Reasons for aging social tenants to stay in their current dwelling according to them			
	Description of suitable dwelling and environment for aging-in-place based on the physical, social, and functional aspects			
	Explaining aging social tenants' unpreparedness for the future			
	Aging social tenants' judgement on the ability to age in place in their current dwelling and environment			
Demand housing associations	Housing associations preference to continue the flow of households by moving elderly to senior houses			
	Reasons for aging social tenants to stay in their current dwelling according to housing associations			
	Housing associations description of a suitable dwelling and environment for aging-in-place based on the physical, social, and functional aspects			
Response prior intervention	Reasons tenants are resistant to energy renovation plans of housing associations			
	Living discomfort in houses before renovation			
	Housing associations tailored energy improvement approach			
	Participation of social tenants in the renovation process			
	Communication approach housing associations with tenants in energy renovations projects			
Response post intervention	Experiences of aging social tenants before and during the renovation process			
	Comfort after completion of renovation project			
	Energy performance of the dwellings			
	Insecure aging social tenants in energy renovation projects			
Barriers	Aging population resulting in change in housing demand and housing shortage			
	Reasons not to integrate aging in place features in energy renovations			
	Regulations delaying the process			
	Inefficiency in the renovation process			
	Responsibility municipality and responsibility gap			
Opportunities	Aging-in-place features as a motivator to continue the energy transition			
	Opportunities to integrating aging in place features in energy renovations defined by housing associations			
	Opinion of aging social tenants on splitting dwellings			
	Considerations for the portfolio strategy of housing associations			
	Responsibility housing associations			
	Improving communication and guidance process with aging social tenants			

Addressed directly 


Addressed indirectly 

Figure 20 | Insights addressed or indirectly addressed by interviewees (own figure)



## Chapter 4 | Empirical results

### 4.2 | Aging social tenants' preferences and needs



## 4.2 | Preferences and needs of aging social tenants

*What are the preferences and needs of aging social tenants for aging features blended in energy renovation?*

This chapter captures the preferences and needs of aging social tenants for their dwellings and environment. Furthermore, it focuses on their experience through the whole renovation project. Four interviews and a quantitative analysis of a survey from Woonbond (2021) on the experience of social tenants regarding their renovated dwellings are conducted. The needs and preferences of aging social tenants are collected from two different cases. In the first case, the dwellings of housing association Beta are stripped to the casco, which stays original, and new elements are added to the casco to improve the energy performance and building quality. For this renovation project, the tenants need to move to a temporary home. In this case, two aging social tenants, both single and female, are interviewed. In the second case, are the dwellings of housing association Alpha renovated, there were only windows and doors replaced, mechanical ventilation installed, floors and roof insulated and façades improved. In this case, the aging social tenants could stay in their homes during the execution of the renovation project. A single woman and a couple were interviewed for this case.

### 4.2.1 | Qualitative results

#### Process responses

Housing associations noticed resistance of aging social tenants towards energy renovation plans when they need to get their approval, this is confirmed by the aging social tenants. The main reasons for this, according to them, are the rent price increase and the hassle. The main reasons housing associations hear from their tenants are discomfort during the execution phase and distrust. However, in the end, all interviewees mentioned that they enjoyed the time during execution and had a positive experience.

---

*Interviewee A - “No, the person who is guiding us now, I find them truly perfect. They just check in occasionally via Whatsapp to see if everything is going well. That's really fantastic. I haven't experienced that before here.”*

*Interviewee B - “I find it wonderful to see what the men are all going to do. How everything goes. I enjoy that, the hustle and bustle, because I'm alone, so I see all that, I'm not chasing after men, you know my husband passed away and I've never had anyone else, but I just enjoy seeing that. And the guys are nice. It is great, it gives me a boost.”*

*Interviewee C – “I dreaded it terribly, oh terribly. I dreaded it for a whole year. But it actually turned out to be not so bad. Yes, they were decent workers, and we made good agreements.”*

*Interviewees D.F – “They came over for coffee, it was really fun.”*

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The tenants of Alpha were satisfied with the comfort of their renovated dwelling, the tenants of Beta could not give an opinion on this matter since the renovation has not been completed yet. Alpha also noticed the positive feedback from their tenants about the comfort of their renovated dwellings.

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*Interviewee 4 “The nice thing is that whenever we carry out or do something like that, afterwards we often receive all sorts of positive reactions. Their house is much easier to heat. It's much more comfortable or their energy bill is much lower. So that's nice to hear.”*

---

Additionally, all were satisfied with the communication approach of the housing associations during the renovation project and didn't have recommendations. The tenants appreciated the information gatherings, renovation updates, personal check-in via WhatsApp, walk-in house for questions about the renovation project in the neighborhood, and the personal visit from a housing association representative to inform them about the renovation project. Only, the tenants of Beta mentioned that the phase before the renovation was executed was uncertain because they didn't know if the buildings were going to be demolished or renovated, and if they needed to move or not. Especially, for the aging tenants this phase costs an enormous amount of energy due to the uncertainty. Having to move twice was too much for most of the aging social tenants. The aging social tenants expressed distrust about housing associations not being truthful regarding obtaining 70% approval and making decisions that benefit them without truly listening to tenant unions.

### **Aging-in-place needs and preferences**

The interviewees considered physical, social, and functional aspects to contribute to aging-in-place and enhancing the quality of life, confirming the importance of including all aspects stated by the literature research. The interviewees were aged between 68 and 81 and most of them had difficulty recognizing their future needs if they were to become less mobile, as they still felt vital and capable of living independently.

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*Interviewee A – “And stairs, I just can't imagine a time when I won't be able to manage them anymore. That's strange.”*

*Interviewee B – “I'm aware of my age, but because I still go everywhere by bike, train, and who knows what else, and walk with the dog. But you know, in 5 years, it could be very different, I don't know, so it's very difficult.”*

*Interviewee C – “I once bought a shopping cart, it's in the basement, and I think, well, at least I have that. But no, I have no idea. No, no idea what I need then.”*

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Alpha recognizes the unpreparedness of the aging tenants.

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*Interviewee 5 – “Yeah, they just want to stay in their familiar environment. That's actually 80% of it, and if they start to have some health issues, then they start to think about it.”*

---

Additionally, the vitality of the aging social tenants is also one of the main reasons why they want to stay in their current dwellings. Other reasons are the benefits of a single-family house, attachment to the environment, and the insufficient supply of senior dwellings. Alpha confirms the attachment to the environment as one of the reasons to stay, plus the rent price increase. The elderly couple who preferred to move to a senior dwelling mentioned the rent price increase as a consequence they are willing to accept. The other aging social tenants didn't give the rent price increase as a reason to stay in their homes. The benefits of single-family houses include an extra bedroom, a garden, and room for storage.

Some building features that could help with aging-in-place, according to aging social tenants, include a stairlift, a spacious dwelling with a spare room, a toilet near the bedroom, no doorsteps, a tag that alerts a nurse in case of an emergency, and grab bars. Additionally, a comfortable inner climate and effective noise control were important for enhancing comfort levels. Figure 21 presents an overview of the building features suggested by the elderly as necessary for aging-in-place. Notably, many functionalities of spaces were mentioned, and the importance of spacious dwellings with a spare room was emphasized. Beyond the functionality of space, sensory comfort was highly valued by most participants, including improvements in temperature, ventilation, daylight, and noise. Interviewee C only mentioned noise improvements as a building feature for aging-in-place and could not think of other features necessary for independent living.

<div> <b>Dimensions</b>  <i>Feng et al. (2018)</i> </div>				
<div> <b>Degrees</b>  <i>Lorkeers et al. (2021)</i> </div>		<i>Personal safety</i>	<i>Sensory comfort</i>	<i>Functionality of spaces</i>
	<i>Casco</i>	No steps ( <i>B</i> )	Warm dwelling ( <i>A,B,D,F,M</i> ) Sufficient insulation ( <i>A, D,F,M</i> ) Patio ( <i>A</i> ) No draught, good ventilation ( <i>A</i> )	Wide doorways and stairs ( <i>D,F,M</i> ) Spacious dwelling ( <i>A, B</i> ) Spacious bathroom ( <i>B, D,F,M</i> ) Single-story dwelling ( <i>B, D,F,M</i> ) Extra spare room ( <i>B, D,F,M</i> ) Toilet near bedroom ( <i>A, B</i> )
	<i>Fixed adaptations</i>		Enough sunlight ( <i>A</i> ) No draft through cracks ( <i>A,B,D,F,M</i> ) Noise improvements ( <i>A,B,C,D,F,M</i> )	
	<i>Portable home adaptations</i>	Grab bars, handrails ( <i>A</i> ) Emergency bell for nurse ( <i>D,F,M</i> )		Stairlift ( <i>B, D,F,M</i> )

Aging in place features in dwellings according to aging social tenants

*A* = Interviewee A addressed the feature

*B* = Interviewee B addressed the feature

*C* = Interviewee C addressed the feature

*D,F,M* = Interviewees D.F and D.M addressed the feature

*Figure 21 | Building features for aging in place valued by the aging social tenants (own figure based on Feng et al. (2018) and Lorkeers (2021))*

The dwellings of the tenants are appropriate for aging-in-place according to them. This is in contrast with the description and opinion of the housing association on the suitability of homes for aging-in-place. The aging social tenants' unawareness of their needs for aging-in-place, makes their judgment on the suitability of one's dwelling questionable. Apart from the physical aspects that were mentioned by the aging tenants, some functional aspects were needed for aging-in-place. Nearby the dwelling needs to be a mailbox, bus stop, and a supermarket according to the tenants. A pharmacy was valued but not necessary since one can use delivery services for this nowadays. When focusing on the social aspects that can help with aging-in-place, the tenants mention it is important to have spaces in the neighborhood for social gatherings, however, they would not make use of it themselves. The main reason for this is their independence and being able to entertain themselves.

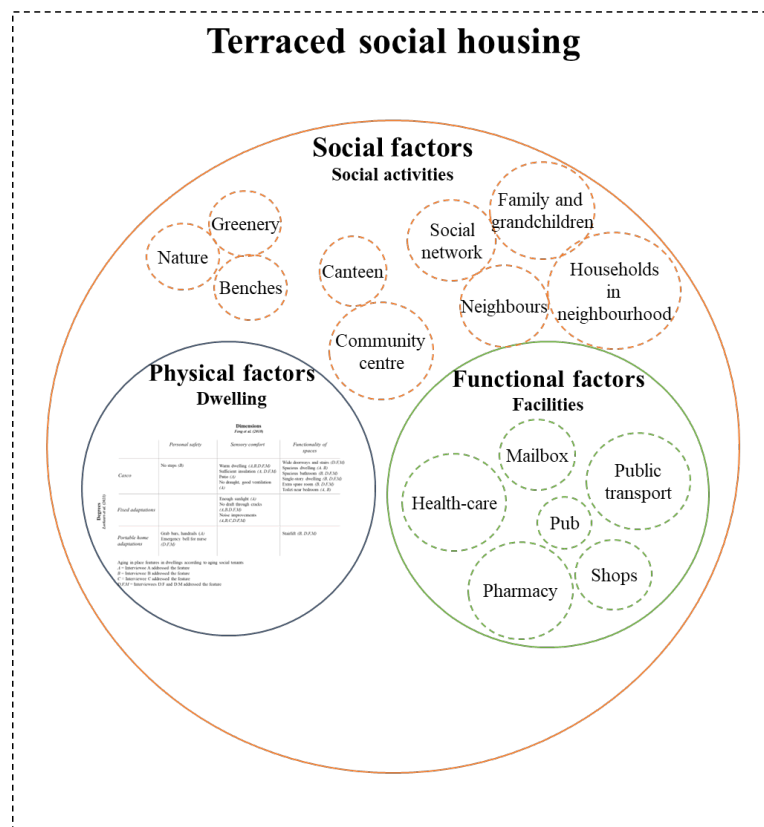


Figure 22 | Social and functional aspects for aging-in-place suggested by aging social tenants (own figure)

Another social aspect that is highly valued is the type of households living in the neighborhood. This is related to the concern about noise nuisance. Additionally, the tenants live in dwellings constructed between 1900-1920 and all mentioned that the houses are noisy and that this is a nuisance. The following quotes emphasize that noise nuisance is a barrier to age in place.

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*Interviewee A – “If the neighbor placed his mobile phone next to his bed, I could hear that. It's very noisy, it's ridiculous, and of course, you could hear everything else too. And one neighbor left, I still keep in touch with her, but she left because of drafts, moisture, and the noise.”*

*Interviewee B – “No, because I once lived there, and initially, it was all for the elderly. I had a child, and my neighbor had a child. And we were alone, and there were elderly people living there, all being serious. And what did they eventually do? They started bringing in young boys or young girls, mostly boys who are troublesome, to be honest. And they started having parties. That's not acceptable! With loud parties in the garden and so on. You shouldn't do that, so I'm not in favor of a mix. I'm in favor of elderly housing, but then you should only place elderly people in it.”*

*Interviewer – “Is the noise a hinderance?”*

*Interviewee C – “Yeah, I do think so. Because I was just talking about that neighbor who also lives alone. But she herself has a lot of issues with extra noise. And that clashes sometimes. Well, one time she came to the front door, asking if I could vacuum at a different time. And if we had grandchildren here, she also had issues with that.”*

*Interviewee D.F – “We're actually leaving because of the neighbors. Those screaming children.”*

*Interviewee D.M – “There are a lot, I think maybe half of them are foreigners. And those Turks and Moroccans, they're just so loud, but they'll be out on the streets soon. And they make a lot of noise, let me tell you.”*

---

The concern about the type of households as neighbors and noise nuisance was also expressed when the aging social tenants were asked about the possibility of splitting their dwelling in two. All interviewees expressed a lack of enthusiasm for the concept of splitting dwellings due to this reason. Two mentioned that it would feel oppressive and that their privacy would be taken away. The idea that both households would take care of each other felt oppressive, this is in relation to them being vital and independent and not recognizing that in the future they might need this help.

Figure 23 provides an overview of the insights directly or indirectly addressed by the three interviewees. Based on the integrated theoretical framework, the needs and preferences of aging social tenants form a crucial input to address the research gap. First, general background questions were asked to gain a better understanding of the elderly's living situations, as these can influence their needs. The aging social tenants were queried about their preferences to stay or move, and their needs for aging in place regarding physical, social, and functional factors. Moreover, the interviewees were questioned about their experiences with energy renovations, including building performance before and after renovation, the communication and participation process, and the energy performance of the dwellings. This comprehensive approach, guided by the integrated theoretical framework, is essential for



finding effective solutions to integrate aging-in-place features into energy renovations of Dutch social housing.

2nd order Theme	Insights	Interviewees			
		A	B	C	DFM
Demand aging social tenants	Reasons for aging social tenants to stay in their current dwelling according to them				
	Description of suitable dwelling and environment for aging-in-place based on the physical, social, and functional aspects				
	Aging social tenants' unpreparedness for the future				
	Aging social tenants' judgement on the ability to age in place in their current dwelling and environment				
Demand housing associations	Housing associations preference to continue the flow of households by moving elderly to senior houses				
	Reasons for aging social tenants to stay in their current dwelling according to housing associations				
	Housing associations description of a suitable dwelling and environment for aging-in-place based on the physical, social, and functional aspects				
Response prior intervention	Reasons tenants are resistant to energy renovation plans of housing associations				
	Living discomfort in houses before renovation				
	Housing associations tailored energy improvement approach				
	Participation of social tenants in the renovation process				
	Communication approach housing associations with tenants in energy renovations projects				
Response post intervention	Experiences of aging social tenants before and during the renovation process				
	Comfort after completion of renovation project				
	Energy performance of the dwellings				
	Insecure aging social tenants in energy renovation projects				
Barriers	Aging population resulting in change in housing demand and housing shortage				
	Reasons not to integrate aging in place features in energy renovations				
	Regulations delaying the process				
	Inefficiency in the renovation process				
	Responsibility municipality and responsibility gap				
Opportunities	Aging-in-place features as a motivator to continue the energy transition				
	Opportunities to integrating aging in place features in energy renovations defined by housing associations				
	Opinion of aging social tenants on splitting dwellings				
	Considerations for the portfolio strategy of housing associations				
	Responsibility housing associations				
	Improving communication and guidance process with aging social tenants				

Addressed directly

Addressed indirectly

Figure 23 | Insights addressed or indirectly addressed by interviewees (own figure)

### 4.2.2 | Quantitative results

Woonbond and Saint-Gobain's research aims to gain insight into the opinions, wishes, needs, and experiences of the residents involved in improvement and sustainability projects. This research includes homes that were renovated in 2018, 2019, or 2020 and upgraded to a label B or A. The invitations for the questionnaire were sent out in October and November 2022. A total of 787 residents responded to the questionnaire, of whom 697 indicated that they had already been living in the renovated home before the renovation. The respondents are 25 years and older and 64% of this group lives in terraced houses (Woonbond, 2021).

This study focuses on the elderly aged 65 and above. Woonbond and Saint-Gobain defined the age groups as 25-34, 35-50, 51-66, 67-74, and individuals aged 75 and above. Consequently, this quantitative analysis only utilizes data from individuals who are 67 years and older. This sample size includes 245 elderly aged 67 and above (n=245). Eighty-one percent of this group of elderly mentioned that they do not live in a dwelling adjusted for health issues. Among those who do live in adjusted dwellings, the top three modifications are a raised toilet, wall brackets or a walk-in shower, a stairlift, and an electric cooking stove, see Figure 24.

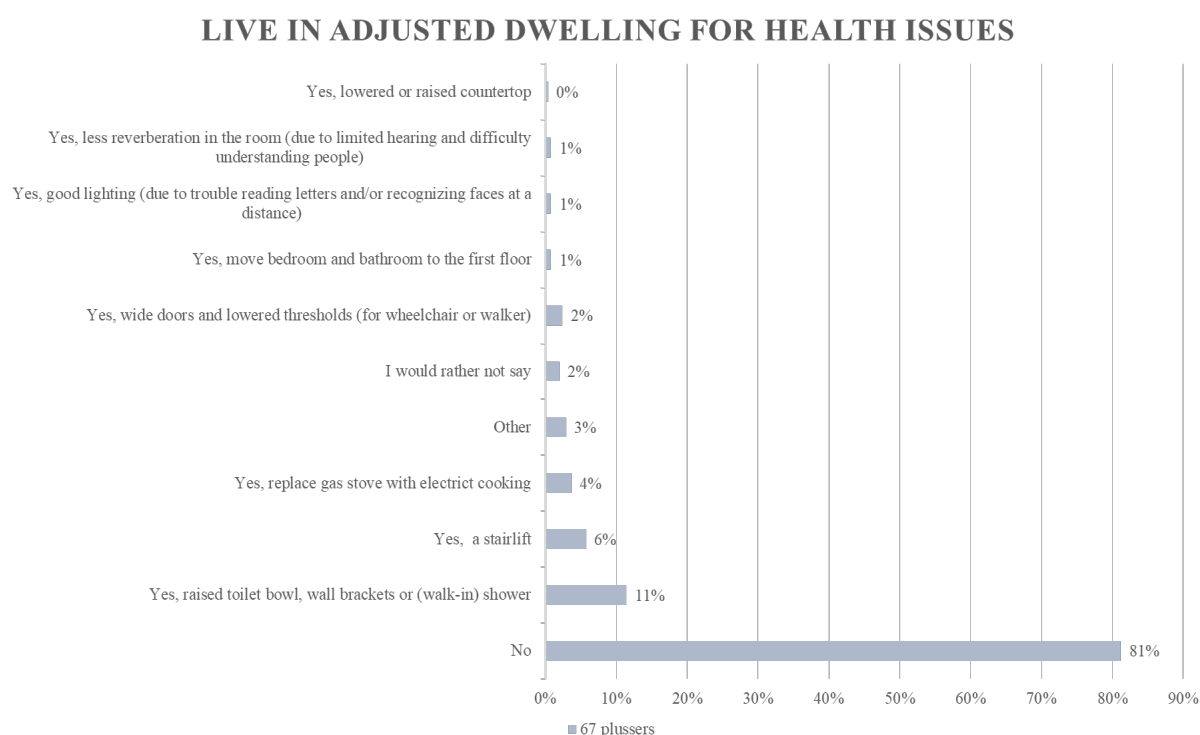


Figure 24 | Do the elderly live in an adjusted dwelling? (own figure, dataset Woonbond (2021))

Furthermore, the data highlights the aspects most valued by the elderly in their dwellings. The top three priorities include safety (78%), healthy and comfortable living (77%), and energy-efficient living (69%), see Figure 25. Healthy and comfortable living encompasses air quality, noise disturbance, daylight, temperature, and draught. The comfort of the dwelling is crucial for aging-in-place (Feng et al., 2018). The high value placed on safety aligns with Aedes (2022), which states that the elderly prioritize safety and stability in their housing environment. Additionally, the top three values rated by the elderly correspond with the home modifications recommended for aging-in-place by the World Health Organization (2015). These include; (1) Physical accessibility, removing obstacles like stairs at the entrance and providing mobility and safety aids, such as grab bars in showers and near toilets; (2) Comfort

enhancements such as improving energy efficiency by installing insulation and draught proofing; (3) Safety, measures to reduce airborne dust and mechanisms to reduce injury, such as installing nonslip flooring in bathrooms. These results indicate that energy renovation, including energy efficiency improvements, contributes to aging-in-place and, consequently, to the quality of life for the elderly.

However, there is a contradiction. Although the elderly value safety, Figure 24 shows that their dwellings lack several safety measures, such as electric cooking, good lighting, stairlifts, bedrooms near bathrooms, and wall brackets or raised toilets. This suggests that aging-in-place features are not integrated into the energy renovations and the houses are not prepared for the future needs of the aging social tenants.

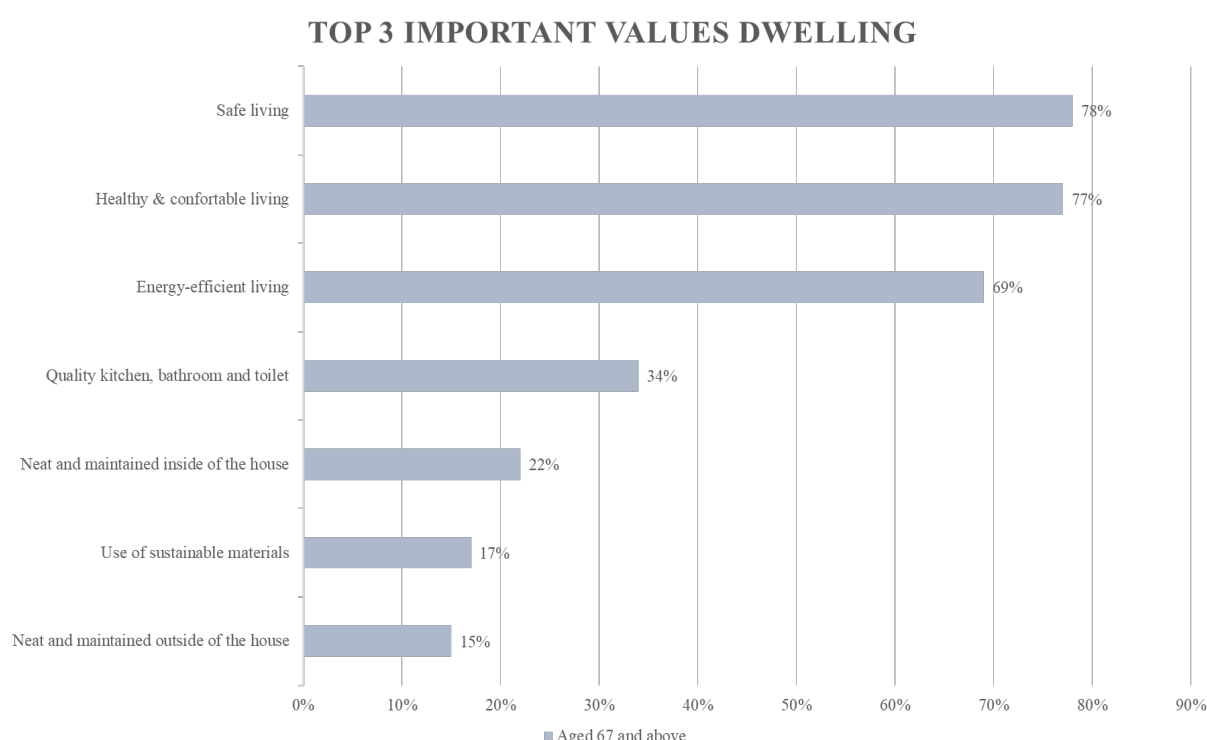


Figure 25 | Top 3 values in the living environment (own figure, dataset Woonbond (2021))

Focusing further on healthy and comfortable living, which the elderly value most in their dwellings, a descriptive analysis was conducted to identify the specific comfort aspects important to them, see Figure 26. The analysis examined the experiences of the elderly post-renovation concerning various aspects of healthy and comfortable living. The elderly were asked whether they had complaints, did not have complaints, or did not know. The results show that the elderly had the most complaints about noise from neighbors, temperature, and draught. This finding aligns with the qualitative research results on the needs and preferences of aging social tenants, where concerns about noise nuisance were particularly emphasized. This means that improving noise nuisance, temperature, and draught support aging-in-place and enhance the quality of life of the elderly.

## COMPLAINTS POST RENOVATION

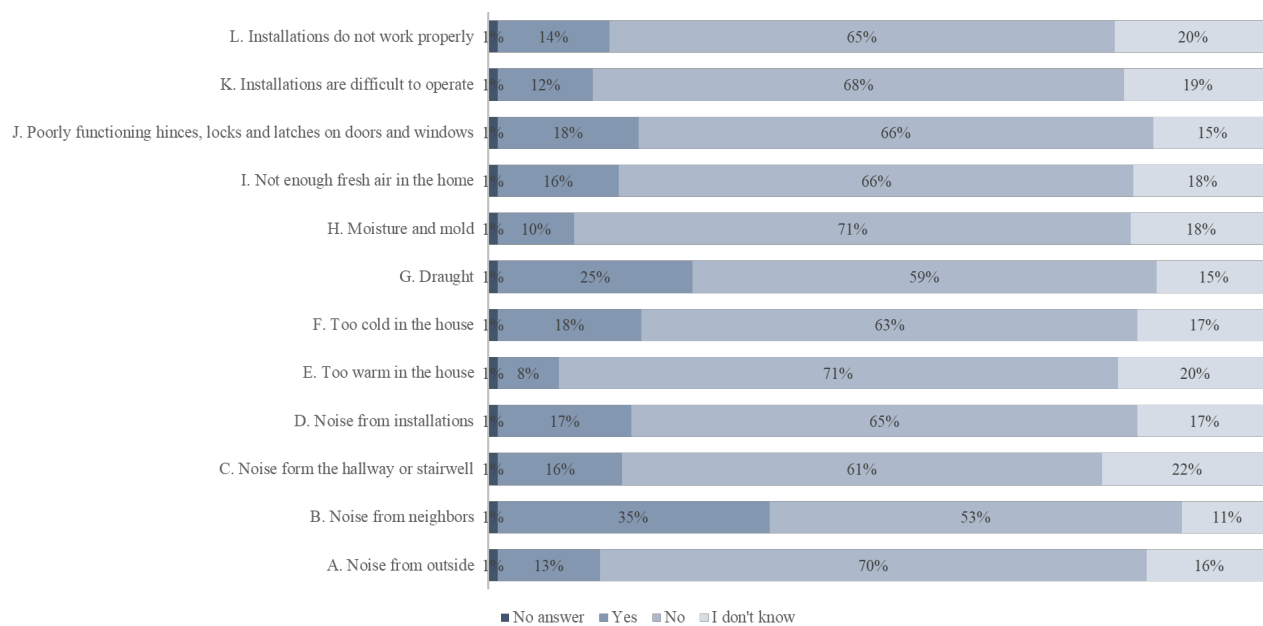


Figure 26 | Complaints post-renovation (own figure, dataset Woonbond (2021))



## Chapter 4 | Empirical results

### 4.3 | Key learnings from initiatives in practice





### 4.3 | Key learnings from initiatives in practice

*What are the key learnings from initiatives to integrate aging-in-place improvements in energy renovations?*

#### 4.3.1 | Case 1: Splitting dwellings

##### Case description

Housing association Gamma is busy renovating its current building stock to respond to the housing shortage and the needs of aging social tenants. One of their concepts is splitting dwellings. This way, aging social tenants can stay in their current dwelling and familiar environment and pay less rent. The housing association can house more aging households. The situation that occurs most is that couples move into the apartment building and eventually one of them has to move to a nursing home or deceases. The houses are too expensive for one person. Splitting the house reduces the rent price resulting in aging tenants having money left to spend on different things, being able to stay in the community, still have enough living space, and reducing the amount of cleaning tasks. This is the response Gamma received from the tenants living in divided dwellings. It seems that one in five out of the 1000 respondents is open to sharing a home with another household and 15% is open to dwelling splitting, out of a total of 3000 tenants.

Gamma only has apartment buildings, therefore this case includes apartment buildings being split. However, it is highlighted that splitting dwellings is also possible for single-family houses but this is more complicated. Interviewee 6, the real estate manager of Gamma, is the expert interviewed for this research question. The buildings of Gamma are quite energy-efficient, splitting dwellings is not driven by the need to be more energy-efficient. Occasionally, some features are implemented to improve the energy performance of the dwellings, however, it is not the intention to add something extra in terms of energy efficiency.

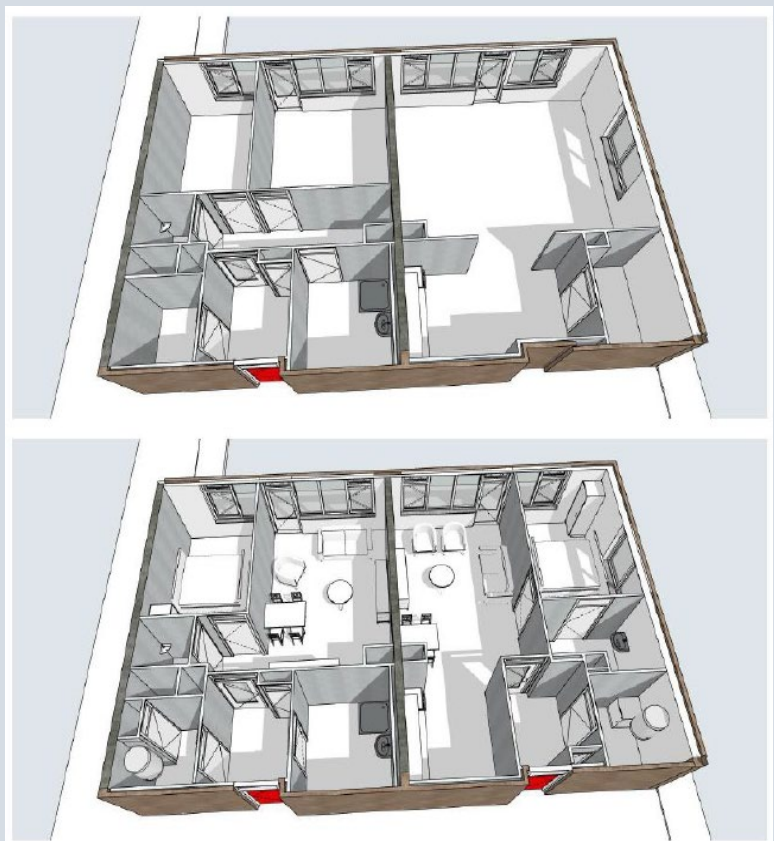


Figure 27 | Splitting dwelling (source: Gamma)

Dwelling splitting is one of the five construction concepts of Gamma. Apart from splitting dwellings Gamma is also considering topping up (adding additional floors or levels to an existing building), subtopping (adding dwellings in the plinth of an existing building), sharing accommodation, and construction of new dwellings. This case focuses on splitting dwellings.

There are multiple reasons why Gamma chooses to renovate and split dwellings instead of constructing new buildings. First, new construction takes more time, on average 10 years, due to finding a location and permit procedures. Second, all the facilities that are valued and required for seniors to age in place are already in the building and environment, so that doesn't need to be organized anymore. The importance of facilities in the building and environment for aging people is emphasized, such as meeting spaces and space for mobility scooters in the building. Furthermore, it is essential to have shops, healthcare facilities, and especially public transportation near the building. Lastly, the costs of splitting are cheaper than building completely new houses.

Gamma splits dwellings on request or when a dwelling is unoccupied. Meaning that one or a couple of dwellings are renovated at a time and not the whole building at once. Gamma chooses to have workers and construction activities in the building for an extended time instead of completing the entire building at once. This decision is made to avoid evicting people from their homes, as it is considered very disruptive, especially for the elderly. Interviewee 6 even referred to it as "inhumane". Furthermore, it's complicated to evict tenants due to their rights. Gamma doesn't need the approval of tenants to continue with the execution of splitting dwellings. The main reason for aging tenants to split their dwellings is because the rent price will decrease. Reasons why this group is hesitant to the concept are because of the reduced living space, fewer rooms, and the discomfort of the renovation.

Figure 28 shows an example floorplan of an apartment that is split in two. Notable, this layout considers wide hallways, a turning radius for wheelchairs and walkers, and a spacious bathroom. Both houses have their own entrance accessible via a shared hallway.



Figure 28 | Floorplan split dwelling (source: Gamma)

These dwellings are situated within an apartment complex that features a range of amenities on the ground floor, including a coffee corner, hairdresser, and pharmacy. It is emphasized that neighborhood facilities are vital for aging in place. Proximity to healthcare facilities, shops, and especially public transportation is essential for elderly residents. Additionally, the importance of social activity is highlighted, as maintaining social connections and community engagement is crucial for the elderly. Gamma's decision to allocate dwellings is primarily driven by the existing organization of these social and functional aspects. Elderly residents are able to continue utilizing the same dentist and healthcare services. If these elements are not already in place, they should be arranged to ensure that elderly residents can successfully age in place.

The most significant barrier to dividing dwellings is the municipality's regulations and procedures. Housing association Alpha also experienced delays due to parking regulations, which postponed their plans to split a dwelling by a year. The house numbering ordinance, known as *huisnummerbesluit* in Dutch, causes delays in the process. This is because, in the Netherlands, many private parties purchase large houses and divide them into multiple units to increase rental income or sell the properties again. These private parties are commonly referred to as *slumlords*. The municipality is conscious of this issue and tries to regulate this because they don't want a building stock that only exists of tiny houses. To maintain quality standards mandated by the municipality, a house numbering ordinance has been implemented to address this issue. However, this has inadvertently caused delays for social housing associations. Their primary goal is not profit, but rather to retain the properties in their portfolio and continue housing the same households within the buildings. Without a house number, a house does not exist. This means that Gamma is not allowed to rent out a dwelling without a house number and is unable to request utility connections. Another difficulty with splitting dwellings is the technical possibilities. The dwellings need to have a minimum square meter, and depending on the techniques used in the building it is easier or more difficult to split a dwelling. However, interviewee 6 states that every project involving installations and technologies will have its challenges, but that splitting dwellings is not extra challenging compared to other projects. Lastly, the housing association tries to avoid unrest in the residential building and keep the tenants satisfied.

To manage these barriers, three key takeaways are concluded. First, arrange partnerships and collaboration with the municipality. Gamma met with the municipality to discuss Gamma's vision and plans, where these plans deviate from how the procedure is currently set up and how Gamma can achieve acceleration. It is suggested to look for possibilities together with the municipality of how acceleration of the permit procedures can be done without compromising the quality of decision-making and other matters of the municipality. Second, a good communication process with tenants is of essence to avoid unrest and dissatisfaction of the tenants. It is advised to inform residents promptly, explaining why you're doing it, what the tenants will notice, and especially what the benefits are. Furthermore, explaining that indeed there will be some inconvenience, but that it will be kept to a minimum. Additionally, inform the tenants about the planning and show them the end result. Lastly, the preparation phase takes longer than expected. However, take the time to align with the municipality and solve technical difficulties in this phase.



Literature confirms the challenges that Gamma encounters during the splitting of homes. According to Aedes (2023a) municipal policies can be time-consuming or even obstructive. Consider, for example, parking requirements and permit applications. Additionally, there must also be suitable houses that, after splitting, result in rentable units (Aedes, 2023). Dorenbos et al. (2023a) add to this that, apart from national and local laws and regulations challenges, there are more barriers. These include personal, cultural, or societal preferences (such as not wanting to move or share a home), reluctance to deal with the hassle, unfamiliarity with certain options, high costs, and technical complexity. The tips from research and practice are first to investigate whether neighboring homes can be shared, as this leads to an efficiency gain. Second, involve the municipality in the planning process from the start to avoid potential issues with municipal regulations, such as parking standards, later on. Lastly, explore the possibility of collaborating with the municipality, making it easier to organize housing splitting (Aedes, 2023a).

#### 4.3.2 | Case 2: Renovating studios to apartments for the elderly

##### Case description

Delta is an organization focused on elderly care. At 16 locations, they provide residential care and nursing care in the client's own homes. Additionally, they offer district nursing and well-being services (daycare activities) and assist clients with treatments and rehabilitation. Depending on their financial situation, people can either rent independently or receive care with accommodation. To facilitate the separation of housing and care, each unit is equipped with its own house number and a metered connection to utilities such as electricity, heat, water, fiber optics, and cable TV (CAI). Delta actively contributes to climate goals and the Green Deal with the healthcare sector. Renovation or transformation opportunities are used to make a building energy-neutral or energy-efficient by investing in reducing energy demand and sustainable energy generation.

Delta owns 30% of their portfolio and the rest is rented from housing associations. Their vision is that the elderly should be able to live independently at home for as long as possible with the help of their social network and with the support of assistive devices in the dwellings. And if this assistance and support is no longer sufficient, Delta will provide nursing staff to help. This vision is based on Delta's recognition of the demographic change in their tenant population. Their clients are aging and in 15 years there is a doubling of the number of people needing care. It is not feasible for Delta to continue delivering care as it is organized now, since the number of caregivers remains the same while their amount of clients will be doubled. Therefore, Delta's ambition is to renovate dwellings with assistive devices for the elderly to age in place with the help of their social network. The case that is studied renovates senior studios into senior apartments with assistive devices.

Delta provides five different living-care concepts. The first is protected group living with nursing care. This provides a protected environment for residents with high-intensity care needs who cannot live independently. Residents live in fully equipped 2-room apartments with support from partners and family, ensuring a comfortable and supportive living arrangement. Second, sheltered individuals living with nursing care. This living arrangement is for residents with high-intensity care needs who can manage their own lives with some support. Residents live in full social rental apartments with nearby care services and have the option to meet others in common areas. Third, individuals living with community nursing. Residents live individually in regular housing with access to community nursing services. They utilize community facilities at the location, providing opportunities to interact with other elderly residents with varying care needs. Fourth, individuals living without professional care. These residents live independently in regular housing without professional care but with mutual support from other residents. This setup includes a mix of ages and families, encouraging intergenerational support and social interaction. The fifth living-care concept is community and living facilities. These facilities are designed for both residents and the neighborhood, promoting natural social interaction. They integrate with the community, providing open and accessible spaces for everyone.

Currently, Delta is renovating studios for individual living without professional care to independent living apartments with assistive devices. The reason for this is the change in the needs of the aging social tenants. The studios had a shared bathroom and living room. However, according to Delta, aging social tenants value their privacy. The tenants prefer to try to live independently for as long as possible. This is exemplified by the following quote.

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*Interviewee 7 – “But that was a choice made 20 years ago to create all these small studios of 16 square meters, with corridors, and then the bathroom facilities separate from the studio. So, essentially, you had to get out of bed, cross the corridor, and then go to the bathroom. And you shared that with another studio. We’ve said we simply don’t find that acceptable anymore. These clients themselves admit it because they just miss privacy. They’re giving up all the privacy they had at home. You’re just walking down the hall in your pajamas, going to the bathroom, and you’ve lost your privacy. And that has an impact on the clients.”*

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The assistive devices help with everyday living activities such as showering and going to the toilet. Examples of these devices are a shower blow-dryer this way elderly don’t need to dry themselves with a towel, and a bidet toilet which cleans the elderly. The renovation of the apartments is not finished, therefore no feedback from the tenant's perspective is given on the end result. It is important to consider whether to move the elderly to a temporary home during the renovation, as the tenant population mostly consists of people aged 85 and above. Most of the tenants deacease in about a year when they move into one of the dwellings of Delta, meaning their “last years” will be in discomfort of the renovation project or in a temporary home. This resulted in some negative feedback from the tenants.

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*Interviewee 7 – “So, it’s a bit of a concern when they come to us, and they know we’re renovating, which means they’ll just be living in a mess or in temporary accommodations until they die. This is not always viewed as positive.”*

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In this process of renovating dwellings for aging social tenants, three key learnings from practices are emphasized. First, Delta notices a lack of knowledge among housing associations about the design of a house for the elderly to live longer independently at home. It is argued that housing associations with more capacity have more knowledge on this subject because they often have a separate department specialized in real estate for target groups that need care. Delta advises housing associations to collaborate with care providers to optimize the dwelling design for the elderly to age in place. Second, an urgency for suitable dwellings for the elderly to live longer independently at home needs to be created among housing associations and municipalities. Delta state that renovating the existing building stock will be a major assignment coming years. Care providers face the challenges of the aging population in their everyday work activities. Therefore, the urgency is well known for care providers, but to a lesser extent to municipalities and housing

associations since they don't experience these challenges every day. Delta visits multiple housing associations and municipalities to create this awareness. Third, the ambition level between the collaborating parties should be the same. Requirements for this are understanding the vision of all parties involved and how they operate. For example, housing associations need to understand how care is provided. This is important before collaboration is established. Delta states that the better the parties know each other the easier it is to get along. It is important to understand the underlying ideas and reasoning for their operations. In summary, parties need to understand each other's vision, needs, and in which direction they want to go.

In response to these challenges, lack of knowledge, urgency, and various ambition levels among housing associations regarding aging-in-place, Delta designed a model dwelling that is suitable for the elderly to live longer independently at home. Currently, one of the senior dwellings of Delta is renovated into a model dwelling for aging-in-place. This model-dwelling is expected to play a crucial role in the new concept of "home, with the care of Delta". It is designed to show future residents, close relatives, and family, employees, collaborating partners how aging tenants can live longer independently at home with the support of home-and-care technologies. The layout and design of the home, together with care technology and aids, are expected to enhance the independence and self-reliance of the resident. This resident is an elderly person who requires intensive care and support. The model-dwelling aims to inform and enthusiast future residents and collaborating partners, and inform and train care professionals and employees of Delta. The collaborating partners include; the municipality, housing associations, contractors, etc. The model-dwelling includes various home-and-care technologies that are currently available on the market, such as the shower blow-dryer, bidet toilet with dryer, front door control, orientation lighting, smart smoke detector, curtain control, sunshade control, light control (lamps), and temperature control. All technologies can be tested and a television is present for presentations. Control of, for example, the lighting and curtains can be done via physical buttons as well as through a tablet.

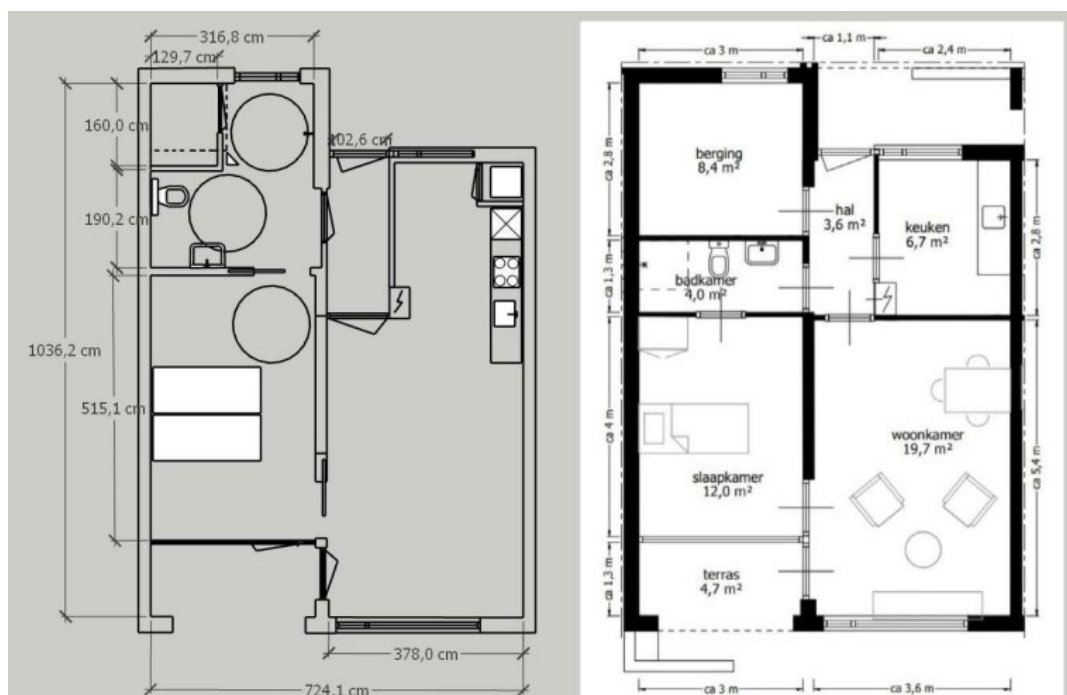


Figure 29 | Floorplan model-dwelling (source: Delta)



The floorplan on the left shows the layout of the model-dwelling for independent living of aging tenants. The floorplan on the right is the current layout of the dwelling that is going to be renovated into the model-dwelling. On casco degree, this dwelling considers the width of the doors being wheelchair-accessible, the turning radius for wheelchairs and walkers, and functionality of space, such as the bathroom located near the bedroom.

### 4.3.3 | Case 1 and 2 combined insights

The barriers and opportunities identified from both cases are presented in Figure 30. The main barriers highlighted by the case studies include regulations that delay the renovation process, a lack of knowledge among housing associations regarding dwelling design for the elderly, insufficient urgency for creating suitable dwellings for aging in place, and technical difficulties. The suggested opportunities to address these barriers involve fostering collaboration between municipalities and healthcare organizations, which includes understanding each other's ambitions and visions. Additionally, aligning with the municipality during the preparation phase can help tackle technical difficulties, and maintaining good communication with residents is crucial. Collaboration with municipalities, care providers, and market parties addresses multiple barriers by creating a sense of urgency among stakeholders, aligning ambition levels, accelerating regulations and permit procedures, and sharing knowledge on elderly housing design. This collaborative approach is organized at the strategic level, with tactical-level managers also included in these efforts to ensure comprehensive and effective implementation.

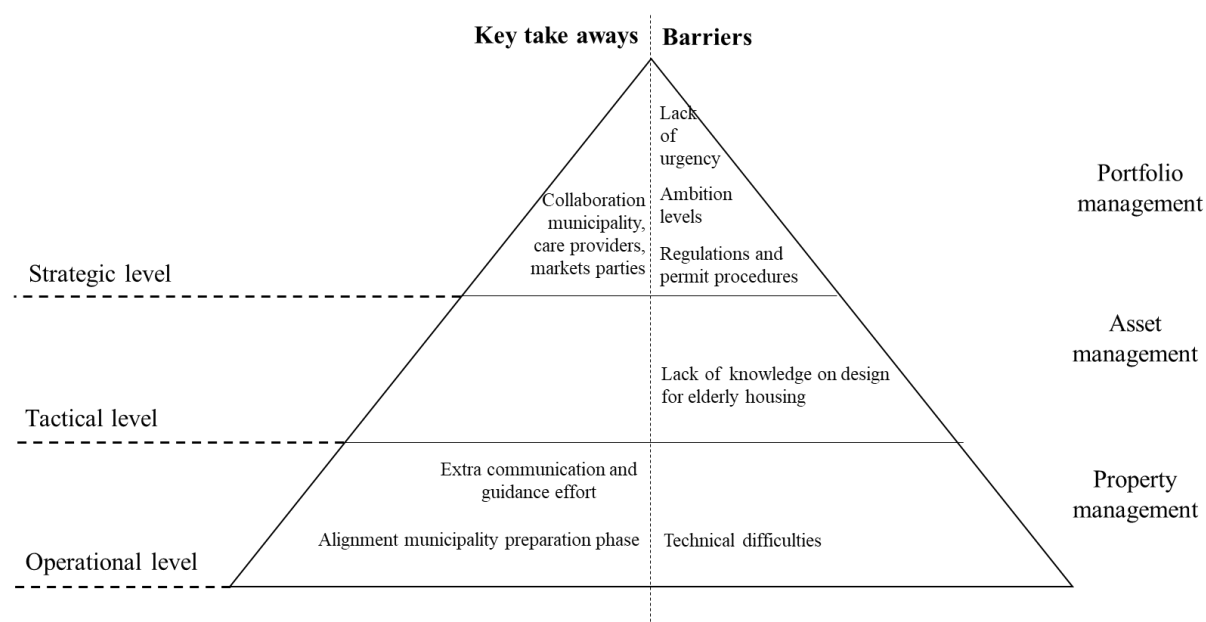


Figure 30 | Key takeaways and barriers from real-life cases (own figure)

Combining insights on building features for aging in place results in the overview shown in Figure 31. Notably, the housing and care provider incorporates portable home adaptations that facilitate aging in place, utilizing these features in the model dwelling. Additionally, most functional features, such as wide doorways, adequate turning radius, mobility scooter parking, a bathroom near the bedroom, and a spacious layout, need to be integrated into the core structure of the dwelling.

Degrees  
Lorkeers et al. (2021)

Dimensions Feng et al. (2018)			
	Personal safety	Sensory comfort	Functionality of spaces
Casco	No steps (7)	Privacy, no shared bathroom and living room (7)	Wide doorways and stairs (7) Turning radius (6, 7) Mobility scooter parking (6) Bathroom near bedroom (7) Spacious dwelling (6)
Fixed adaptations	Orientation lights(7)	Temperature control (7)	Bidet toilet (7) Sliding doors (7)
Portable home adaptations	Smart smoke detector (7) Front door control (7)	Curtain control (7) Sunshade control (7) Light control (7)	Shower blow dryer (7)

Aging in place features in dwellings according to real estate managers  
6 = Interviewee 6 addressed the feature  
7 = Interviewee 7 addressed the feature

Figure 31 | Building features for aging in place suggested by the real estate managers (own figure based on Feng et al. (2018) and Lorkeers (2021))

In addition to the physical factors, both interviewees emphasized the importance of the social and functional aspects of the environment for aging in place. While the physical factors, such as the dwellings, are the responsibility of the housing associations, the social and functional needs must be organized in collaboration with the municipality and healthcare providers.

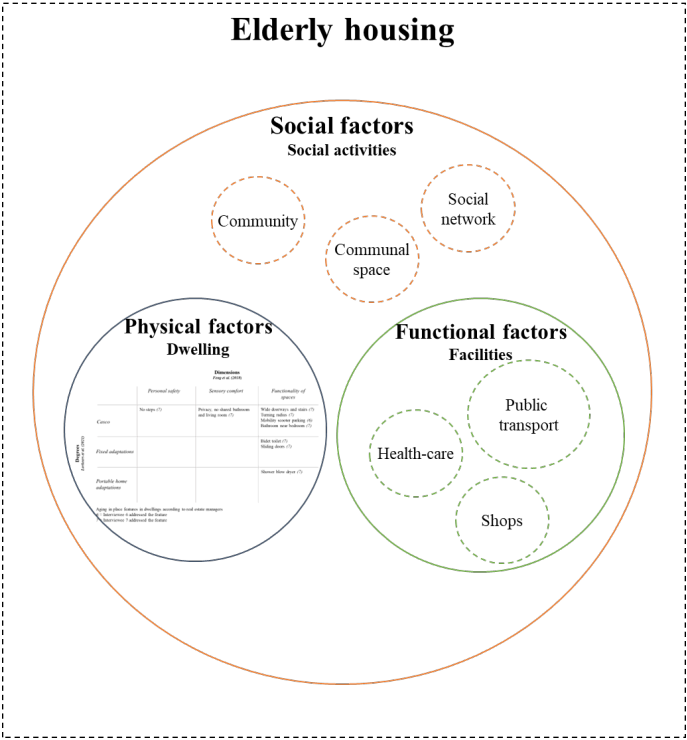



Figure 32 | Social and functional features necessary for aging-in-place according to Gamma and Delta (own figure)

Figure 33 provides an overview of the insights directly or indirectly addressed by the three interviewees.

2nd order Theme	Insights	Interviewees	
		6	7
Demand aging social tenants	Reasons for aging social tenants to stay in their current dwelling according to them		
	Description of suitable dwelling and environment for aging-in-place based on the physical, social, and functional aspects		
	Aging social tenants' unpreparedness for the future		
	Aging social tenants' judgement on the ability to age in place in their current dwelling and environment		
Demand housing associations	Housing associations preference to continue the flow of households by moving elderly to senior houses		
	Reasons for aging social tenants to stay in their current dwelling according to housing associations		
	Housing associations description of a suitable dwelling and environment for aging-in-place based on the physical, social, and functional aspects		
Response prior intervention	Reasons tenants are resistant to energy renovation plans of housing associations		
	Living discomfort in houses before renovation		
	Housing associations tailored energy improvement approach		
	Participation of social tenants in the renovation process		
	Communication approach housing associations with tenants in energy renovations projects		
Response post intervention	Experiences of aging social tenants before and during the renovation process		
	Comfort after completion of renovation project		
	Energy performance of the dwellings		
	Insecure aging social tenants in energy renovation projects		
Barriers	Aging population resulting in change in housing demand and housing shortage		
	Reasons not to integrate aging in place features in energy renovations		
	Regulations delaying the process		
	Inefficiency in the renovation process		
	Responsibility municipality and responsibility gap		
Opportunities	Aging-in-place features as a motivator to continue the energy transition		
	Opportunities to integrating aging in place features in energy renovations defined by housing associations		
	Opinion of aging social tenants on splitting dwellings		
	Considerations for the portfolio strategy of housing associations		
	Responsibility housing associations		
	Improving communication and guidance process with aging social tenants		

Addressed directly 


Addressed indirectly 

Figure 33 | Insights addressed or indirectly addressed by interviewees (own figure)



## Chapter 4 | Empirical results

### 4.4 | How to overcome the barriers





#### **4.4 | How to overcome the barriers**

*How to overcome the barriers when integrating aging-in-place improvements in energy renovations of social housing in The Netherlands?*

##### **4.4.1 | Barriers to overcome**

###### **Different ambition levels**

The level of renovation and vision of elderly housing varies among the housing associations interviewed. Alpha replaced windows and doors, insulated the roof and floor, and installed a mechanical ventilation system in the single-family dwellings. Alpha's opinion regarding the implementation of aging-in-place features in these residences is that it is not feasible to do so in single-family homes, as they are not meant for the elderly to age in place. On the contrary, Gamma's opinion is to make more dwellings for the elderly in the existing building stock, including apartment buildings and terraced houses, to respond to the housing shortage and needs of the elderly. Implying that Gamma does consider terraced houses suitable for the elderly to age in. In contrast to Alpha, Beta renovated the buildings entirely, retaining only the original structure. Subconsciously, Beta rearranged the floorplans beneficial for aging-in-place. However, this was a coincidence and not a deliberate action. Beta's preference, same as Alpha's, is to move out the elderly to senior residentials to make room for households with children. Even though, Alpha mentioned that terraced houses are not suitable for aging-in-place, Alpha started a pilot to split such a dwelling. This means Alpha is aware of the housing shortage and aging population. Delta is strongly aware of the need for suitable dwellings because they are faced with the issues of the aging population every day as a care and housing provider for the elderly. Their dwellings are appropriate for aging-in-place but renovated to meet the current needs of the aging tenants and energy requirements. Furthermore, interviewee 8 emphasizes the importance of implementing aging-in-place features in every renovation. This shows that there are different ambition levels among housing associations regarding energy renovations and aging-in-place. Related to this is the responsibility gap between housing associations, municipalities, and healthcare providers. If one does not feel the responsibility to respond to the needs of the aging social tenants, action will not be taken. Not only do housing associations have varying levels of ambition regarding these social and environmental challenges, but so do municipalities and healthcare providers.

###### **Aging tenants unprepared for the future**

Additionally, the aging social tenants were unaware of the aging-in-place features they might need in the future. Since, these tenants still feel young, vital, mobile, and independent they had difficulty thinking about their future needs. Regulations and waiting lists for senior dwellings can cause conflict with this, if the elderly have to move due to health issues and they are not registered yet, it can take years before they can move. It is important to know the needs of the aging population to optimize the dwelling design. Now, the housing associations decide for the elderly which building features are necessary for aging-in-place and the level of comfort.

###### **Preconceptions and uncertainty impact aging social tenants' openness to home renovation**

Resistance to renovation projects was identified in interviews with housing association managers and elderly social tenants. Admittedly, all tenants had positive feedback and a good

experience during the renovation project. Therefore, the aging social tenants' preconceptions of renovation projects need to change to mitigate the resistance. Furthermore, aging social tenants experienced uncertainty about the renovation plans causing distress, which should be avoided especially for this vulnerable group. This uncertainty also had an impact on the resistance towards the renovation project.

### **Regulations and permit procedures of the municipality**

Even though some housing associations are still struggling with the flow of households or providing suitable dwellings for aging-in-place, some housing associations realized initiatives to respond to the housing shortage for senior dwellings and the needs of the elderly. One of these initiatives is splitting dwellings, including apartments and single-family houses. The main barriers to executing this initiative are the regulations and permit procedures of the municipality slowing down the process and keeping residents satisfied.

Other initiatives also support aging-in-place. These are innovative care technologies, such as medicine dispensers or shower blow dryers. Aging-in-place and energy transition are innovation issues, there are many developments in both subjects. However, aging-in-place techniques have not been implemented in energy renovations on a big scale yet. While these techniques could support aging-in-place and unburden elderly care providers. Innovation initially costs a lot of money and therefore can be seen as a risk. This creates a barrier to start implementing aging-in-place features.

To conclude the main barriers that need to be resolved to continue energy renovations and respond to the needs of aging social tenants:

1. Different ambition levels result in whether energy improvements and aging-in-place features are realized.
2. Aging social tenants are unprepared for the future causing conflict with the flow of households and don't prepare their homes to be appropriate for aging-in-place.
3. Preconception and uncertainty impact aging social tenants' openness to home renovation. This resistance needs to be mitigated for the continuation of renovation projects.
4. Initiatives to integrate aging-in-place features in renovation projects are delayed due to regulations and permit procedures of the municipality.

#### **4.4.2 | Proposed holistic approach**

##### **Collaboration between municipalities and care providers**

Key learnings from practice show that collaboration between municipalities, elderly care providers, and housing associations is highly important. First, through collaboration awareness and urgency of the social and environmental issues can be created among the parties involved. Second, ambition levels should be aligned in these collaborations to ensure all parties are working in the same direction. For this, it is necessary to understand each other's vision, needs, and underlying ideas of the operations of the parties before collaboration is established. Third, housing associations can optimize dwelling designs for aging-in-place with the knowledge and experience of elderly care providers. Fourth, responsibilities among the stakeholders can be defined to resolve the responsibility gap.

Furthermore, results show that it is possible to integrate aging-in-place features in energy renovation, even for terraced houses. The implementation depends on the vision and willingness of housing associations to make terraced houses suitable for aging-in-place. Results show that demographic changes should be considered in the vision and strategy of housing associations. The implementation of aging-in-place features, such as wide doorways and electrical sockets at sitting height, makes the dwelling universal. This means that the dwelling is not only designated for the elderly by definition but also allows other households to live there.

### **Living coach and counseling**

Aging tenants need to become more aware of their needs in advance instead of when they start experiencing disabilities in everyday life activities due to health issues. A strategy for this is introducing a “living coach” within the housing associations’ organization. The living coach starts a conversation with the elderly to help them prepare for the future. The conversation with the living coach is implemented to work as a trigger for the elderly to start thinking about the future and where and how they want to live. Older people need to be consulted regarding their needs and preferences, rather than assumptions being made on their behalf, and to have some agency over their environment. This may require specific support in some care environments but should be taken seriously. The living coach also advises the elderly to register for senior dwellings because of the waiting list.

### **Extra communication and guidance effort**

Communication and guidance with aging social tenants are crucial to mitigate resistance, unrest, and tenant dissatisfaction. Extra attention to the aging social tenant group is necessary. The aging social tenants had positive feedback on the communication during the renovation project. The results show that it is important to communicate the benefits the project will have for the aging social tenants, inform the residents promptly about the project and planning, explain why renovation is necessary, what the tenants will notice and what the inconvenience will be, but how it will be kept to a minimum. Lastly, show the tenants the end results. The results show that implementing aging-in-place features for the aging tenants could work as a motivator to mitigate resistance. Including these features in the renovation project can be part of the communication strategy to highlight the benefits to the aging social tenants. Moreover, apart from implementing aging-in-place features, higher levels of comfort could also work as a motivator for aging social tenants. A healthy inner climate, warm house, and noise reduction are also part of the benefits that the housing association can present to the tenants. The results emphasize the main concern of the social tenants about the noise nuisance and type of households as neighbors. The renovation project can consider building improvements to reduce resistance and meet the needs of aging social tenants. Ensuring the noise nuisance will be less after the completion of the renovation project and ensuring which type of household will live next to them, can take away the tenants' concern. For this, the renovation project needs to take measures to reduce the noise, such as new windows, new doors, and insulating walls and floors. Ensuring which type of household will be living next door is not in every case feasible. Results show that communication initiatives were appreciated by the tenants. The ways of communication that were appreciated are; good agreements, gatherings with housing association and tenants to inform about project, updates during the project, personal check-in

via Whatsapp and a walk-in house to ask questions about the renovation project or share concerns. These communication tools should be considered by the housing associations for energy renovation projects. Results show that tenants want to have the feeling that housing associations know their situation and that they are not overlooked. Therefore, visiting aging social tenants in person is important to explain the situation and **listen to their concerns**.

### Collaboration with the municipality and market parties

Regulations and permit procedures delay initiatives to realize more senior dwellings and enable tenants to live longer independently at home. Results show that collaboration with municipalities is necessary to reduce the duration of permit procedures. Alignment and partnership with municipalities are important. It is advisable to discuss with the municipality about the housing association's vision and plans, opportunities in collaboration with the municipality, where the plans deviate from the current procedure set-up, and how the housing association can achieve acceleration.

Aging-in-place and energy transition are innovation issues. Results show that the costs should be shifted to market parties. Market parties and developers need to be provided with the perspective that if innovation is successful it can be implemented on a bigger scale. Collaboration needs to be enhanced between housing associations and market parties to implement more innovative care techniques and energy improvement systems. For this, the input of care providers is necessary to understand how care is provided and what is necessary for aging-in-place.

In conclusion, the following approach is proposed to overcome the barriers:

1. Collaboration with municipalities, elderly care providers, and housing associations to create urgency and align ambitions.
2. Living coach and counseling to prepare aging social tenants for the future.
3. Extra communication and guidance effort for the elderly to mitigate resistance towards energy renovations
4. Collaboration and alignment with the municipality to speed up the process for renovation and aging-in-place initiatives

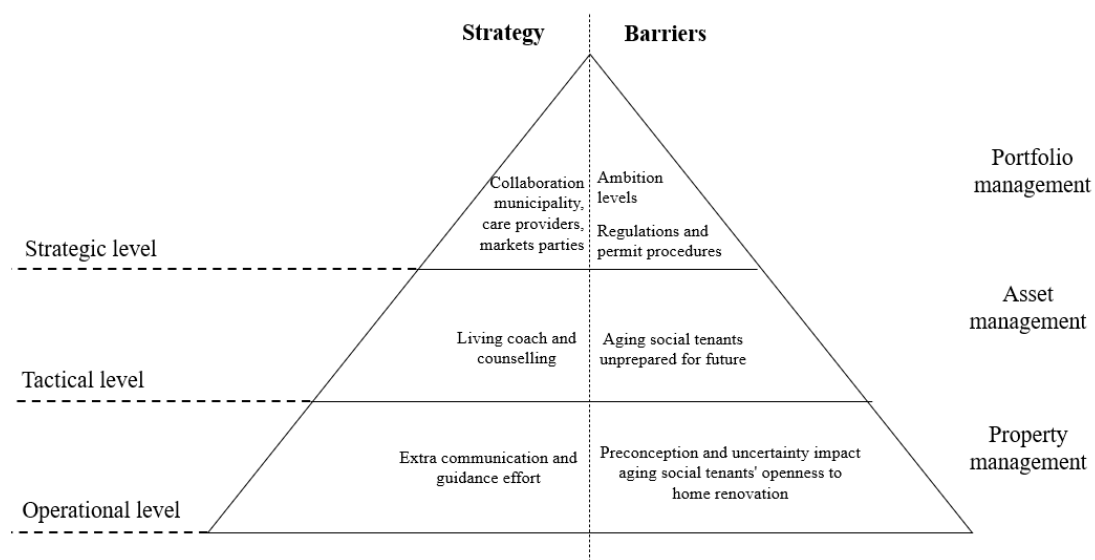


Figure 34 | Strategy recommendation to overcome barriers (own figure)



#### 4.4.3 | Validation

The barriers and strategy are proposed to an expert who currently works for the municipality, but also has experience as a strategic manager of a housing association and as a director of a platform aimed at helping organizations with issues regarding aging-in-place. The housing associations interviewed for this study are recognized by the expert as progressive, validating that even these progressive organizations face challenges regarding the tension between renovating and implementing aging-in-place features. It is acknowledged that the tension between the two issues, continuing the energy transition and aging-in-place, exists because the stakeholders in one issue may be different from those in the other issue. The barriers presented were recognized by the expert, who had experienced and dealt with these issues in practice. In addition to the presented barriers, the expert adds that innovative devices, such as a medicine dispenser, are not used in practice even though information and inspiration are provided by the market and best practices. Whilst these innovative devices can help the elderly to live independently and minimize the assistance needed from care providers. It is argued that the energy transition and aging-in-place are innovative issues. The expert proposes collaborating with market parties for innovation and providing them with the perspective that successful innovation can be implemented on a larger scale. An opportunity is to shift the innovation costs, which are often initially very high, to be carried by the market, within agreements.

The results show that the ambition level should be defined including which position the housing association takes in the energy transition and issues regarding aging-in-place. The expert would prioritize leading by example and incorporate the small adjustments for aging-in-place into energy renovation projects. Energy improvements can be achieved autonomously, whereas constructing a suitable home for aging-in-place, in an environment that is not, doesn't help the aging tenant. Therefore the minimum housing associations can do is implement aging-in-place features in energy renovations. However, the expert adds to involve the social aspect in this matter. For this higher ambition level, collaboration with municipalities, insurance companies, and elderly care providers is necessary to arrange the social and functional aspects of aging-in-place.

The proposed strategy on extra communication and guidance effort is confirmed by the expert, which is highlighted with the following quote.

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*Interviewee 8 - "Providing proper guidance for elderly individuals during renovations would be crucial. Yes, guidance is essential."*

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The expert also confirms and highlights the importance of creating awareness and urgency. The expert would advocate the issue more, pushing it to the forefront in places where one has influence. Apart from this, the expert sees potential in the concept of splitting dwellings which is presented as an opportunity to respond to the housing shortage and social issues. The following quote exemplifies this:

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*Interviewee 8 – “The issue of shared housing is quite intriguing, especially concerning prolonged independent living and from a social standpoint. For instance, if an elderly couple is living on the ground floor with a young individual renting the upper floor, there's potential for mutual benefits. This could involve the younger tenant providing some supervision or assistance with errands. I believe in the potential of such arrangements.”*

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In addition to the proposed strategy, the expert adds that the allocation of housing should be incorporated into housing associations' regular operations. This is to ensure that every opportunity is taken to place the right tenants in the right homes.



# Chapter 5 | Discussion and conclusion

5.1 | Discussion

5.2 | Conclusion





## 5 | Discussion and conclusion

### 5.1 | Discussion

The integrated theoretical framework underscores the importance of considering three key aspects for successful aging-in-place: the physical environment (dwelling), social factors (social activities), and functional elements (access to neighborhood facilities) according to Vanleerberghe et al. (2017). Empirical findings from this study validate the significance of all three aspects in facilitating independent living for the elderly, as highlighted by the insights gathered from interviewees. Deursen (2023a) notes that housing associations are currently undergoing a transitional phase as they collaborate with the government to address the housing crisis. The empirical study adds to theory, the importance of collaboration between housing associations and municipalities to meet energy requirements and the needs of the aging population. Housing associations face multiple challenges in the energy transition. First, the housing associations need 70% approval of the tenants whose homes will be renovated. Second, the result of renovation not only has to meet the energy performances but also building, noise, architectural, and urban performances (Aedes, 2023). Empirical research underscores the importance of enhancing not only energy performance but also comfort and indoor climate, as aging social tenants often express dissatisfaction with noise, cold, mold, and drafts in their dwellings. Enhancing the comfort level for aging social tenants can reduce resistance towards energy renovations.

The barriers listed by the integrated theoretical framework—(1) state regulations and agreements; (2) aging tenants resistant to moving; (3) small dwellings; (4) stakeholder collaboration; (5) the need for an age-friendly environment; (6) inefficiencies in health-care services—were all addressed by the managers in the empirical research, supporting the literature. Additionally, the empirical results highlight key barriers to integrating aging-in-place in energy renovations, namely differing ambition levels among stakeholders, the unpreparedness of aging social tenants, and their preconceptions and uncertainty impacting their openness to home renovations. Both the integrated theoretical framework and empirical research underscore innovation, large dwellings, universal design principles, improved healthcare services, and stakeholder collaboration as opportunities to integrate aging-in-place features in energy renovations. The empirical research further identifies the implementation of a living coach and improving communication and guidance in renovation projects as additional opportunities. This highlights the unique context of Dutch social housing.

The three dimensions—personal safety, sensory comfort, and functionality of spaces—are particularly relevant for Dutch social housing. Empirical results indicate that the elderly prioritize safety, comfort, and energy efficiency as their top three concerns. While Feng et al. (2018) do not include energy efficiency in their criteria, the World Health Organization (2015) states that comfort encompasses improving energy efficiency. Enhancing energy efficiency is directly linked to comfort, as installing insulation and draught-proofing results in a warmer home with fewer drafts. For Dutch social housing, it is essential to include energy efficiency as a criterion for aging-in-place to enhance comfort for active aging. Energy renovations aim to improve the energy efficiency of dwellings, thereby also supporting aging-in-place. This synergy ensures that both energy efficiency and aging-in-place objectives are achieved simultaneously. The importance of comfort is emphasized by the integrated theoretical framework and the elderly in the empirical research, however, the managers of the housing associations didn't address comfort to support aging-in-place, see Figure 35. This synergy is



beneficial for both environmental and social issues and housing associations should become aware of this. A critical aspect of comfort that is often overlooked in energy renovations is noise reduction. Although noise reduction measures do not directly enhance energy efficiency, empirical results show that most complaints and concerns among residents are about noise. Feng et al. (2018) also include control of noise disturbance as a criterion for comfort, highlighting its importance.

Figure 35 shows that most interviewees, particularly housing associations, describe a suitable dwelling for aging-in-place with features arranged in the casco of the dwelling that enhance the functionality of spaces. These features include wide doorways and stairs, spacious dwellings, spacious bathrooms, single-story layouts, extra spare rooms, toilets near bathrooms, turning radius, and mobility scooter parking. According to the literature, these features are universal design principles (World Health Organization, 2015). Implementing these features with energy renovations in the casco of the dwelling is more expensive and time-consuming compared to portable adaptations for aging-in-place, as they often involve significant structural changes, such as rearranging the floor plan to widen hallways. However, depending on the level of energy renovation, such as the comprehensive renovations undertaken by the tenants of housing association Beta, where dwellings were stripped to the casco, it is much easier to implement these features. Depending on the level of renovations, housing associations should consider which aging-in-place features can be cost-effectively implemented. As the strategic manager suggests, aging-in-place adjustments should be realized in every energy renovation. However, there is a lack of knowledge about multiple other effective aging-in-place features that can be considered as fixed and portable adaptations. Figure 35 shows that interviewee 7, a manager of a housing and care provider, addresses multiple aging-in-place features that no other interviewee considered. Additionally, interviewee 7 observed a lack of knowledge about dwelling design for the elderly among housing associations. This indicates that housing associations should gain more knowledge of the various possible aging-in-place features available. Increasing awareness and understanding of these features can help housing associations effectively integrate them into renovation projects, considering all three degrees and dimensions described by Feng et al. (2018) and Lorkeers et al. (2021), thereby enhancing the quality of life for elderly residents. The empirical results suggest collaboration between housing associations, municipalities, and care providers to share knowledge, align ambition levels, and determine suitable housing criteria. PBL (2019) confirms that collaboration between these stakeholders can foster the development of integrated solutions tailored to the needs of the aging population (PBL, 2019). New building designs should adopt these universal design principles for the casco, ensuring that the foundation is age-friendly and robust against population changes. This approach allows dwellings to be further adjusted with both fixed and portable adaptations to meet specific needs. Aging-in-place is not a one-size-fits-all concept, its realization varies across individuals and contexts, requiring flexible and innovative approaches (Bigonnesse and Chaudhury, 2021). Therefore, dwelling design must be adaptable to the various needs and preferences of the aging population.

		Dimensions <i>Feng et al. (2018)</i>	
		<i>Personal safety</i>	<i>Sensory comfort</i>
Degrees <i>Lorkeers et al. (2021)</i>	<i>Casco</i>	No steps ( <i>B</i> ) (4,5,8) (7) Electrical sockets, HVAC control, and switches fixed at sitting height (8) Automatic door opening (5)	Warm dwelling ( <i>A,B,D,F,M</i> ) (7) Sufficient insulation ( <i>A, D,F,M</i> ) Patio ( <i>A</i> ) No draught, good ventilation ( <i>A</i> ) (5) Privacy, no shared bathroom and living room (7)
	<i>Fixed adaptations</i>		Enough sunlight ( <i>A</i> ) No draft through cracks ( <i>A,B,D,F,M</i> ) Noise improvements ( <i>A,B,C,D,F,M</i> )
	<i>Portable home adaptations</i>	Grab bars, handrails ( <i>A</i> ) (4,8) Emergency bell for nurse ( <i>D,F,M</i> ) Front door control (7) Smart smoke detector (7) Orientation light (8) (7)	Curtain control (7) Sunshade control (7) Light control (7)
Aging in place features in dwellings addressed by the interviewees		Managers housing associations:	
Aging social tenants:		Real estate manager:	
<i>A</i> = Interviewee A		<i>6</i> = Interviewee 6	
<i>B</i> = Interviewee B		<i>7</i> = Interviewee 7	
<i>C</i> = Interviewee C			
<i>D,F,M</i> = Interviewees D.F and D.M			

Figure 35 | Features for aging in place addressed by all interviewees (own figure, Feng et al. (2018); Lorkeers (2021))

The integrated theoretical framework indicates that housing associations are responsible for providing suitable dwellings for aging-in-place. However, the surrounding environment also needs to be age-friendly, a responsibility shared among various stakeholders, including municipalities, healthcare providers, and market parties. Empirical research highlights several social and functional aspects suggested by interviewees for age-friendly environments, as illustrated in Figure 36. Notably, many different stakeholders are involved in implementing these social activities and functional factors. Housing associations play a crucial role in this process by strategically locating elderly target groups within their portfolio, ensuring they are not situated far from the social activities and facilities essential for aging-in-place. Proper placement is also vital for fostering social connections and participation. Empirical results indicate that aging social tenants express concerns about the types of households in their neighborhood, particularly regarding disturbance and safety. Thus, careful consideration of neighborhood composition is necessary to address these concerns and promote a supportive, age-friendly environment. The integrated theoretical framework presents a conceptual model for aging-in-place within neighborhood environments, emphasizing the importance of meaningful social connections—both formal and informal—to reduce isolation and enhance place attachment and integration. Social participation, including volunteering and community engagement, strengthens aging-in-place by fostering connections and a sense of belonging. Mobility, particularly walking, is central to aging-in-place as it supports access to resources and social interactions, facilitated by accessible transit and services. Proximity of services and amenities is also considered in this framework. Independence, influenced by social support and participation, enables older adults to control their environment and meet daily needs



housing associations' primary responsibility of providing adequate housing. While it acknowledged the significance of social and functional aspects of aging-in-place within the environment, it did not delve into the specifics of designing and arranging the environment to foster an age-friendly neighborhood. The literature and empirical research indicate that all three aspects—suitable dwellings, social activities, and facilities—must be integrated to achieve effective aging-in-place. A suitable dwelling alone is insufficient without an age-friendly environment. Therefore, further research is necessary to explore the design of age-friendly environments and the coordination among the multiple stakeholders responsible for this.

For practice, my view is to lead by example in energy renovations by adopting universal design principles to accommodate diverse households can enhance portfolio resilience. The board of directors should incorporate this into the organization's vision and strategy to ensure alignment and guide decision-making following that vision. Additionally, this vision should also be included on a national level. Government directives mandating universal design in energy renovations might incentivize housing associations to optimize dwelling designs for aging populations. Additionally, organizational learning and knowledge sharing among stakeholders are crucial for addressing the challenges posed by an aging population and advancing the energy transition. In my view, housing associations alone cannot effectively address the challenges and tensions inherent in balancing energy renovation with the needs of aging-in-place. Collaborative efforts among organizations are essential, enabling them to draw from each other's experiences, best practices, and expertise to collectively tackle the challenges posed by an aging population and advance the energy transition of existing building stock. It is essential that all stakeholders involved recognize the urgency of addressing this social and environmental issue. Without a sense of urgency, progress in energy and aging-in-place initiatives will be hindered, impeding their implementation and effectiveness. Moreover, it is not solely the responsibility of housing associations to meet energy requirements and address the needs of the aging population. While it is beneficial for housing associations to take the lead and set examples on how to tackle the challenges of climate change and an aging population, other sectors beyond social housing should also consider universal design principles to remain robust against population changes. Urgency and awareness among architects and contractors need to be created to ensure that new dwellings incorporate universal design. Although multiple studies emphasize the importance of universal design, there appears to be a gap between the literature's requirements and the practical implementation of these principles in both renovations and new constructions. Further research should focus on how universal design can become a standard practice in residential design, ensuring that all new homes are accessible and adaptable to meet the needs of a diverse population.

### **Limitations**

However, it is essential to acknowledge the limitations of this study, including its context-specific nature and the need for broader comparative research to validate findings across diverse housing associations and geographical settings. Moreover, the study's reliance on a small sample size of aging social tenants and a single housing association may limit the generalizability of its findings. The small sample size of aging social tenants included four tenants of which three were single women around 70 years old. This makes the results less representable for aging households thus limiting the applicability for generalization. To



address this limitation, quantitative research was employed. However, the quantitative analysis was further constrained by the survey questions provided by Woonbond, and the available variables did not fully capture all aspects of the research topic. Specifically, the nuanced needs and preferences of aging social tenants for aging-in-place and the detailed aspects of energy renovation projects were not thoroughly represented. Consequently, not all the qualitative findings could be generalized through quantitative research.

Using secondary data means having limited control over how the data was collected, including the sampling methods and data collection techniques used. This lack of control can introduce biases or errors that the researcher cannot easily identify or correct. The original data collectors' biases and objectives may influence the data, impacting its suitability for the current research. Secondary datasets often lack detailed contextual information that could be vital for a comprehensive analysis. Additionally, survey questions may be interpreted differently among the respondents. The variability in interpretation can lead to inconsistent responses, which undermines the reliability of the data. Moreover, if the questions do not consistently measure what they are intended to measure, the conclusions drawn from the data may be flawed. For instance, if respondents have different interpretations of "energy efficiency", the resulting data may not accurately reflect their actual experiences or attitudes toward energy renovations.

The dataset did not include sufficient relevant data points necessary to explore and establish correlations between variables significant to this study. This limitation restricted the depth of the analysis and the ability to uncover meaningful relationships. Due to these limitations, only descriptive analysis was conducted. Descriptive statistics provided insights into the basic characteristics of the data, such as means and frequencies. While these findings offer an initial understanding, they do not enable the testing of hypotheses or the establishment of correlations.

## 5.2 | Conclusion

Demand for age-friendly houses is growing due to the aging population, necessitating a proactive approach to renovating homes for the elderly. Simultaneously, housing associations are expected to take the lead in the energy transition of the existing building stock, which requires renovation of their portfolio to meet the energy requirements. This study was undertaken to investigate the integration of aging-in-place features within energy renovations of social housing in the Netherlands. The research aimed to explore several key aspects, including the opportunities and barriers to integrating aging-in-place improvements, the preferences and needs of aging social tenants, lessons learned from existing initiatives, and strategies to overcome integration challenges. To achieve this, interviews were conducted with various stakeholders, including housing associations, elderly care providers, municipalities, and aging social tenants. Additionally, case studies and quantitative research were employed to gather comprehensive insights. This study delivers a holistic approach to integrated aging-in-place features in energy renovation for Dutch social housing.

Several barriers were identified in the process of integrating aging-in-place features into energy renovations. These include varying levels of ambition among housing associations, inadequate preparation of aging social tenants for future housing needs, preconceived notions and uncertainties among tenants leading to resistance towards renovation, and delays in initiatives due to regulatory and permitting procedures. Opportunities were identified in addressing the tension between energy renovations and aging-in-place. Among these is the concept of splitting single-family houses, allocating the ground floor to accommodate aging social tenants with age-friendly features, while younger occupants reside upstairs, potentially providing support to the elderly. Additionally, a shift from focusing solely on dwellings to enhancing the living environment through collaboration among housing associations, municipalities, and care providers is recommended to support aging-in-place. Further innovation and collaboration with market parties are necessary to effectively address these social and functional aspects of the environment.

Through interviews with aging social tenants and a quantitative survey analysis from Woonbond, insights were gathered on tenant experiences with housing association Beta's renovations requiring temporary relocation, and Alpha's in-place energy upgrades. Despite initial resistance due to concerns over rent increases and renovation hassle, tenants reported positive experiences and improved dwelling comfort post-renovation, highlighting the importance of effective communication and support during the renovation process. The findings underscore the need for further adjustments to facilitate aging-in-place, including improvements in noise control, temperature regulation, and physical accessibility features.

Key learnings from existing initiatives show that the main barriers to aging-in-place renovations include regulatory delays, insufficient knowledge among housing associations, a lack of urgency, and technical difficulties. To address these, fostering collaboration between municipalities, healthcare organizations, and market parties is crucial, as it helps align ambitions, share knowledge, and improve communication with residents. This collaborative approach ensures effective implementation by addressing multiple barriers and integrating necessary physical, social, and functional features into dwellings.

To overcome the identified barriers a strategic approach is proposed for housing associations. This involves enhancing collaborations between municipalities, elderly care providers,

insurance companies, and housing associations to foster urgency and awareness, align ambition levels, incorporate social aspects of aging-in-place, and optimize dwelling designs for the elderly. Providing counseling through a living coach can help prepare aging social tenants for their future housing needs while gaining insights into their preferences. Additionally, increased communication and guidance efforts tailored to the elderly are essential for this target group to support the energy transition and alleviate distress and uncertainty. Regulations and permit procedures delay initiatives for senior dwellings, highlighting the need for collaboration with municipalities to expedite permit processes. Additionally, to foster innovation in aging-in-place and energy transition, it's recommended to shift costs to market parties and enhance collaboration between housing associations, market entities, and care providers for the implementation of innovative care techniques and energy improvement systems. Incorporating housing allocation considerations into the regular operations of housing associations can further facilitate the integration of aging-in-place features into energy renovations.



## Chapter 6 | Reflection





## **6 | Reflection**

The Master's track in Management in the Built Environment focuses on realizing a sustainable built environment, with a particular emphasis on addressing the needs of end users and various stakeholders. This track is dedicated to finding solutions for the development and management of urban areas, portfolios, and buildings. My personal interest lies in creating housing solutions for vulnerable and lower-income groups, ensuring they have adequate living conditions where they can carry out their daily activities without disruption. Additionally, I am passionate about providing comfortable housing that meets energy requirements to mitigate climate change. Combining these interests into a single research project has allowed me to delve deeper into the complexities of these social and environmental issues.

### **Research results**

The tension between energy renovations and aging-in-place was more complex than expected. There are many aspects influencing the decision-making of whether to improve both issues. Housing associations are in principle housing providers, however, most take an extra step and provide social services because they feel that they have this responsibility. Whereas in middle-segment rental housing, the owners don't feel the responsibility to help tenants with social issues, for example helping the elderly to get care services, or assigning a neighborhood assistant, or making sure there is a community hub in the environment. In my opinion, it is already a good start that housing associations feel this responsibility and take this extra step because most of the time they deal with vulnerable tenants. However, housing associations don't need to carry this responsibility, of taking the lead in the energy transition and renovating their dwellings to be age-friendly, on their own. In my opinion municipalities, care providers, insurance companies, and market parties should also take this responsibility and help each other to achieve the energy goals and suitable housing for the elderly. For this, awareness and urgency are necessary. The aging population is growing, and a doubling of this demographic is anticipated. It is concerning to observe that the elderly are ill-prepared for the near future, especially considering its immediacy. Moreover, the current infrastructure, including both the building stock and healthcare services, is inadequately equipped to accommodate the anticipated increase in aging individuals. This lack of preparedness should serve as a stark warning to housing providers, urging them to adapt their dwellings to be universally accessible and responsive to the needs of aging residents. Presently, we are unprepared to address the challenges posed by the aging population, a situation that warrants serious concern. Therefore, it is essential to raise awareness of this issue and bring it to the forefront of societal and market agendas. While the process may be complex, it is crucial to confront these challenges head-on.

### **Methodology**

Incorporating a statistical analysis in the quantitative research would have been advantageous for the results. This combination of methods could have provided a more comprehensive and robust understanding of the tension between energy renovation and aging-in-place. Additionally, expanding the scope to include interviews with a more diverse group of aging social tenants would have provided a deeper understanding of the needs and preferences of this demographic. On a positive note, the semi-structured interviews were a good way to better understand the underlying reasons behind the needs and preferences of aging social

tenants. Additionally, the interviews allowed for emotion to be expressed, something that wouldn't have been possible with a survey. Embracing varied research methods has enriched my personal learning experience, offering valuable insights into different methodological approaches.

The organizational level framework provided a structured approach to organizing the empirical research findings. Additionally, it guided the selection of interviewees to ensure comprehensive identification of barriers and opportunities. Initially, the research focus was restricted to the physical aspects, specifically the dwellings of the housing associations. However, literature research emphasized the importance of adopting a holistic approach, not only physical considerations but also social and functional aspects, for effective aging-in-place strategies. This realization resulted in a methodological redesign, expanding the scope of the research to incorporate social and functional aspects as well.

The limited sample size compromises the generalizability of the research findings, as the quantitative analysis fails to offer transferability for all the qualitative results. Consequently, the findings and conclusions lack generalizability to broader contexts, potentially yielding geographical variations, among other factors. While the relevance of the topic is emphasized, the applicability of the research findings across diverse situations is constrained. Therefore, additional research is warranted to enhance the comprehensiveness and validity of the findings.

## **Process**

Reflecting on the research process, I found great satisfaction in conducting interviews and engaging with stakeholders. Hearing the perspectives of housing associations, municipalities, and elderly tenants involved in energy renovation projects was particularly enlightening. However, logistical challenges and time constraints posed significant hurdles. Changes in methodology following the initial project phase, coupled with delays in obtaining tenant contact information from housing associations, disrupted the research timeline. Despite these setbacks, the momentum gained from conducting interviews fueled my enthusiasm for the research. I was intrigued by the tenants' lack of foresight regarding their future needs, which differed from my initial expectations. I expected to get a long list with building features and other aging-in-place needs, however, this was not the case. Furthermore, the guidance and insights provided by my mentors were invaluable, helping me navigate data analysis and refine my research direction. Overall, while the research process presented challenges, it also provided valuable learning experiences and opportunities for growth. Following P4, I incorporated quantitative analysis into my methodology, which provided valuable insights and expanded my skill set in utilizing statistical software such as SPSS. This experience enabled me to discern appropriate statistical tests for different types of data, enhancing my proficiency in quantitative research methodologies. Reflecting on my journey, I am gratified by the personal growth I have experienced and the passion I have further developed for this topic.

Overall, I reflect on a year filled with joy, learning, and challenges. It has been a period of personal growth, equipping me with valuable skills for the professional world. I am eager to apply all that I have learned and experienced in the work field!

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## **Interview protocol**

### **Interview 1**

Woning corporatie:

Geïnterviewde:

Interviewer: Willemijn Vos

Datum en tijd:

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#### Introductie

Bedankt dat u wilt deelnemen aan dit interview. Ik ben Willemijn Vos en ben momenteel aan het afstuderen van de master Management in the Built Environment aan de Technische Universiteit van Delft.

Dit interview is onderdeel van een master thesis onderzoek aan de TU Delft naar het integreren van voorzieningen voor ouderen om langer zelfstandig te kunnen wonen in renovatie projecten van woning corporaties in Nederland. Woning corporaties worden verwacht de leiding te nemen in de energie transitie van de huidige gebouwde omgeving. Naast deze grote uitdaging wordt de vraag naar geschikte ouderen woningen ook groter door de vergrijzing. Om op beide vragen in te spelen, kijkt dit onderzoek naar de integratie van deze twee vraagstukken. Dit onderzoek in specifiek kijkt naar het renoveren van rijtjeswoningen omdat rijtjeswoningen het meeste voorkomen in Nederland en veel energie gebruiken. Daarnaast woont 35% van de 65 plussers in rijtjeswoningen, en zijn hier de meeste uitdagingen betreft doorstroming, renoveren en geschiktheid voor ouderen. Dit interview zal vooral focussen op de kansen en barriers in de integratie van voorzieningen voor ouderen in renovaties voor rijtjeswoningen.

Voordat ik begin met het interview zou ik toestemming willen vragen om het gesprek op te nemen, ben u akkoord daarmee?

U mag elke vraag die ik stel weigeren om te beantwoorden. Ik zal zorgvuldig met uw gegevens omgaan. Indien vragen onduidelijk zijn of u opmerkingen heeft, stel deze gerust. De resultaten van dit interview en onderzoek worden na afloop van ons onderzoeksproject met u gedeeld.

Nu zal ik met het interview beginnen.

## **Interview vragen SRQ1 & SRQ4 | Portfolio manager (strategisch niveau) – expert interview**

### **Interviewee 8**

#### **Roles interviewee 8:**

- Woningcorporatie – energie neutraal maken portfolio
- GEEF – ouderen huisvesting
- Gemeente – teammanager Sociaal Ondersteunend

#### **Deel 1 | Barriers en kansen**

1. Vanuit uw ervaring bij de woningcorporatie, welke uitdagingen kwam u tegen bij het energie neutraal maken van woningen met ouderen huurders?
2. Terug reflecterend op u tijd bij de woning corporatie en ervaring bij platform GEEF, wat waren de grootste uitdagingen om ouderen langer zelfstandig thuis te laten wonen?
3. Vanuit de gemeente, ziet u ontwikkelingen of kansen op dit gebied?
4. Vanuit alle perspectieve, woningcorporaties, GEEF en de gemeente, kan je mij meer vertellen over de spanning tussen energie renovaties en ouderen langer zelfstandig thuis laten wonen?
  - a. Als u niet vanuit deze perspectieve dat kan zeggen, wat is uw persoonlijke blik hierop?

#### **Deel 2 | Validatie voorstel strategy**

5. Gegeven uw ervaringen, wat is uw perspectief op deze gepresenteerde voorstellen?
  - a. Zou u nog iets toevoegen?
  - b. Zou u iets anders doen?
6. Als u degene kon zijn die alles kon beslissen, directeur van woningcorporatie, hoe zou u de twee doelen combineren in de ideale wereld? (energie transitie continueren en geschikte woningen voor ouderen of zelfstandige te wonen realiseren)

## Interview vragen SRQ1 | Gebied ontwikkelaar (tactisch niveau)

### Interviewee 4

#### Algemene vragen

##### Woning corporatie

1. Wat is u rol binnen de woning corporatie en waar bent u verantwoordelijk voor?
2. Wat is jullie visie en wat zijn jullie bedrijfsdoelstellingen daarbij?
3. *Welke aspecten worden opgenomen in de wijk strategieën?*

##### Energie

1. Wat is u rol en of verantwoordelijkheid binnen de energie transitie van jullie woningvoorraad?
2. Hoe ziet de strategie voor het renoveren van jullie rijtjeswoningen voorraad eruit?
  - a. Tot welk niveau worden de woningen gerenoveerd (welk label), welke onderdelen in het gebouw worden hierbij gerenoveerd?
    - i. Is deze ingreep voor de lange termijn, of korte termijn waarbij over een aantal jaar weer een ingreep nodig is?
3. Hoe worden de bewoners betrokken in het renovatieproces?
4. Worden de ouderen op een andere manier betrokken bij het renovatieproces of anders mee gecommuniceerd in vergelijking met de jongeren leeftijdsgroepen?

##### Ouderen

1. Wordt in de wijk strategieën doelgroepen aan woningen gekoppeld, ook met betrekking tot doorstroming? Hebben jullie een target voor doelgroepen?
2. Wat denkt u dat een geschikte woning voor ouderen is?
3. Welke sociale aspecten denkt u dat van belang zijn voor ouderen om langer zelfstandig te kunnen blijven wonen
  - a. Heeft woningcorporatie hier invloed op of is dit de verantwoordelijkheid voor woningcorporaties?
4. Welke functionele aspecten in de omgeving zijn volgens u van belang voor ouderen om langer zelfstandig te kunnen blijven wonen?
  - a. Heeft woningcorporatie hier invloed op of is dit de verantwoordelijkheid voor woningcorporaties?

##### Barriers

4. Welke barriers zijn er wanneer rijtjeswoningen geschikt worden gemaakt voor ouderen om langer zelfstandig te wonen tijdens renovatie projecten, betreft de fysieke aspecten (de woning zelf)?
5. Welke organisatorische barriers komt u tegen?
6. Welke barriers ziet u in de communicatie en participatie met de ouderen?

##### Kansen

1. Welke kansen ziet u in het renovatie proces van rijtjeswoningen?
2. Welke kansen ziet u wanneer rijtjeswoningen geschikt worden gemaakt voor ouderen om langer zelfstandig te kunnen blijven wonen?
3. Ziet u kansen of barriers in de samenwerking met gemeente en zorgverleners?

## Interview vragen SRQ1 | Sociaal beheer / wooncoach (operationeel niveau)

### Interviewee 5

#### Algemene vragen

##### Woning corporatie

1. Wat is u rol binnen de woning corporatie en waar bent u verantwoordelijk voor?
2. Wat is jullie visie en wat zijn jullie bedrijfsdoelstellingen daarbij?
3. *Welke aspecten worden opgenomen in de complexplannen/beheer?*

##### Energie

1. Wat is u rol en of verantwoordelijkheid binnen de energie transitie van jullie woningvoorraad?
2. Hoe begeleidt u het renovatie proces met de bewoners?
3. Hoe worden de bewoners betrokken in het renovatieproces?
4. Hoe ziet de customer journey eruit voor de huurders tijdens een renovatie project.
5. Welke communicatiemiddelen worden gebruikt voor de communicatie met de huurders met betrekking tot de renovatie?
6. Worden de ouderen op een andere manier betrokken bij het renovatieproces of anders mee gecommuniceerd in vergelijking met de jongeren leeftijdsgroepen?

##### Ouderen

1. Wat is jullie visie voor de doorstroming van huishoudens?
2. Is er een strategie of planning voor de doorstroming van huishoudens in jullie portfolio?
3. Op welke aspecten sturen jullie de doorstroming? Bijvoorbeeld, leegstand, populatie verandering, services?
4. Wat denkt u dat een geschikte woning voor ouderen is?
5. Welke sociale aspecten denkt u dat van belang zijn voor ouderen om langer zelfstandig te kunnen blijven wonen
  - a. Heeft woningcorporatie hier invloed op of is dit de verantwoordelijkheid voor woningcorporaties?
6. Welke functionele aspecten in de omgeving zijn volgens u van belang voor ouderen om langer zelfstandig te kunnen blijven wonen?
  - a. Heeft woningcorporatie hier invloed op of is dit de verantwoordelijkheid voor woningcorporaties?

##### Barriers

1. Welke barriers zijn er wanneer rijtjeswoningen geschikt worden gemaakt voor ouderen om langer zelfstandig te wonen tijdens renovatie projecten, betreft de fysieke aspecten (de woning zelf)?
2. Welke barriers komt u tegen in de communicatie en participatie met de bewoners bij renovatie voorstellen of verhuisvoorstellen?
3. Welke organisatorische barriers komt u tegen?

##### Kansen

1. Waar ziet u kansen om de participatie en communicatie met ouderen te verbeteren bij renovatie of verhuisvoorstellen?
2. Ziet u mogelijkheden en kansen voor de ouderen om wel in hun huidige woning te blijven en de omgeving/huis aan te passen zodat het geschikt is voor ouderen om langer thuis te blijven wonen?



3. Denkt u dat ouderen meer gemotiveerd zijn om mee te werken en betrokken te zijn met renovatie projecten van hun huidige woning wanneer er voorziening voor ze zijn om langer zelfstandig te wonen?
4. *Welke kansen ziet u in het renovatie proces van rijtjeswoningen?*
5. Ziet u kansen of barriers in de samenwerking met gemeente en zorgverleners?

**Interview vragen RQ2 | Case Alpha**  
**Interviewee C & D.F, D.M**

**Algemeen**

1. Wat is uw leeftijd
2. Heeft u een partner en woont u daarmee samen?
3. Heeft u kinderen, zo ja wonen die nog bij u? hoever wonen zij van u vandaan?
4. In wat voor type woning woont u?
5. Hoelang heeft u al in deze woning gewoond? En hoelang woont u al in deze omgeving?
6. Ontvangt u thuiszorg of mantelzorg, of gaat u naar een externe zorgverlening?

**Benodigdheden**

7. Welke fysieke aspecten heeft u nodig in uw woning om langer zelfstandig te kunnen blijven wonen?
8. Welke sociale aspecten heeft u nodig in de woning en omgeving om langer zelfstandig te kunnen blijven wonen?
9. Welke faciliteiten heeft u nodig in de omgeving om langer zelfstandig te kunnen blijven wonen?
10. Hoe zou u uw huidige woning beoordelen betreft de levensloopbestendigheid? Voor hoelang denkt u dat uw huidige woning geschikt is voor uw behoeftes? Wat voor cijfer zou u de woning geven?
11. Is uw omgeving geschikt om lang zelfstandig te kunnen blijven wonen?

**Wensen**

12. Heeft u verhuishensen of wil u het liefst in uw huidige woning blijven wonen en voor hoelang? En waarom?
13. Hoe ziet u ideale woning eruit om zelfstandig te kunnen blijven wonen?

**Verwachtingen**

14. Wat verwacht u van uw woning corporatie betreft het levensloopbestendig maken van woningen? (levensloopbestendig, ouderen langer zelfstandig in de woning kunnen wonen).

**Energie/renovatie proces**

15. Is u woning comfortabel, warm of koud, tocht, schimmel etc.?
16. Zou u geld investeren in deze woningen om het comfort beter te maken?
17. Hoe beoordeeld u de energie rekening?
18. Hoe zou u gecommuniceerd willen worden over de renovatie plannen?
19. Hoe zou u betrokken willen worden bij de renovatie plannen?
20. Wat verwacht u van de woning corporaties in het renovatie proces?
21. Zou u het erg vinden om in een tijdelijke woning te moeten wonen zodat u woning gerenoveerd kan worden om de energie prestatie te verbeteren en de woning levensloopbestendig te maken?

**Concept**

22. Hoe zou u het vinden als u huidige woning gesplitst zodat er twee huishoudens in kunnen wonen waarbij de beneden verdieping bestemd is voor 65 plussers, waar u zou kunnen wonen?

## **Interview vragen RQ2 – Case Beta**

### **Interviewee A & B**

#### **Algemeen**

1. Wat is uw leeftijd
2. Heeft u een partner en woont u daarmee samen?
3. Heeft u kinderen, zo ja wonen die nog bij u? Hoever wonen zij van u vandaan?
4. In wat voor type woning woont u?
5. Hoelang heeft u al in deze woning gewoond? En hoelang woont u al in deze omgeving?
6. Ontvangt u thuiszorg of mantelzorg, of gaat u naar een externe zorgverlening?

#### **Benodigdheden**

7. Welke fysieke aspecten heeft u nodig in uw woning om langer zelfstandig te kunnen blijven wonen?
8. Welke sociale aspecten heeft u nodig in de woning en omgeving om langer zelfstandig te kunnen blijven wonen?
9. Welke faciliteiten heeft u nodig in de omgeving om langer zelfstandig te kunnen blijven wonen?
10. Hoe zou u uw huidige woning beoordelen betreft de levensloopbestendigheid? Voor hoelang denkt u huidige woning geschikt is voor uw behoeftes? Wat voor cijfer zou u de woning geven?
11. Is uw omgeving geschikt om lang zelfstandig te kunnen blijven wonen?
12. Hoe ziet u ideale woning eruit om zelfstandig te kunnen blijven wonen?

#### **Wensen**

13. Heeft u verhuishwensen of wil u het liefst in uw huidige woning blijven wonen en voor hoelang? En waarom?
14. Keert u terug na de renovatie of ziet u het als een kans om naar een gelijkvloerse woning te gaan ergens anders?

#### **Verwachtingen**

15. Wat verwacht u van uw woning corporatie betreft het levensloopbestendig maken van woningen? (levensloopbestendig, ouderen langer zelfstandig in de woning kunnen wonen).

#### **Energie/renovatie proces**

16. Was uw huidige woning voor de renovatie comfortabel, warm of koud, tocht, schimmel etc.?
17. Zou u geld investeren in deze woningen om het comfort beter te maken?
18. Hoe beoordeeld u de energie rekening voor de renovatie?
19. Hoe vond u de communicatie met Parteon tijdens voor het renovatie project?
  - a. Hoe zou u gecommuniceerd willen worden over de renovatie plannen?
20. Hoe bent u betrokken bij het renovatie project?
  - a. Had u meer of anders betrokken willen zijn bij het renovatie project?
21. Wat verwacht u van de woning corporaties in het renovatie proces?
22. Merkte u weerstand vanuit andere ouderen in de wijk tegen de renovatie plannen? Zou dit minder zijn wanneer er voorzieningen voor hen gerealiseerd zouden worden in de gerenoveerde woningen?

#### **Concept**

23. Hoe zou u het vinden als u huidige woning gesplitst zodat er twee huishoudens in kunnen wonen waarbij de beneden verdieping bestemd is voor 65 plussers, waar u zou kunnen wonen?

## **Interview vragen RQ3 - Expert interview – Gamma**

### **Interviewee 6**

#### **Algemeen**

1. Wat is uw rol binnen SOR en waar bent u verantwoordelijk voor?
2. Wat is jullie motivatie om woningen te splitsen?
  - a. Is er belang of wens vanuit ouderen om hun woning te splitsen? Wordt dit aangevraagd door de ouderen zelf?
3. Hoeveel woningen hebben jullie al gesplitst? Wat voor type woningen zijn dit?
4. Wat is de overweging om woningen te gaan splitsen en niet nieuw te bouwen? Ook qua kosten?
5. Is het woning splitsen samen met gemeente of andere partijen? Krijgen jullie er subsidies?

#### **De woningen / proces**

1. Moet de woning aan bepaalde eisen voldoen om gesplitst te kunnen worden?
2. Zijn er fysieke barriers wanneer woning gesplitst worden
3. Zijn er organisatorisch obstakels voor het splitsen van woningen waar jullie tegen aan gelopen zijn?
4. Zijn er obstakels in samenwerkingen met andere organisaties/partijen in het proces om woningen te splitsen?
5. Met welke aspecten moet rekening gehouden worden wanneer woningen worden gesplitst?

#### **Ouderen**

6. Hoe verloopt het proces met ouderen huurders, betreft de communicatie en participatie?
  - a. Tijdelijke woning?
  - b. Weerstand?
7. Welke voorzieningen voor ouderen treffen jullie in de woningen zodat ouderen langer zelfstandig kunnen wonen?
8. Komen in beide woningen ouderen terecht, of komt er een ander huishouden in de tweede woning?
9. Realiseren jullie ook sociale voorzieningen en faciliteiten in de omgeving? Of door middel van samenwerkingen?

#### **Energie/renovatie**

10. Wanneer jullie de woning splitsen verbeteren jullie ook de energie prestatie van de woning?  
Zo ja, hoe?
11. Was de huidige staat ook erg oncomfortabel voor de bewoners?
12. Feedback bewoners na renovatie en splitsen?

#### **Tops**

13. Wat gaat er goed in het proces om woningen te splitsen? Als je tip zou mee geven

#### **Negatief / tips**

14. Wat gaat er nog niet goed in het proces? Wat moet er verbeterd worden of oplossingen naar gezocht worden?



## **Interview vragen - Expert interview – Delta**

### **Interviewee 7**

#### **Algemeen**

1. Wat is uw rol binnen IJsselheem en waar bent u verantwoordelijk voor?
2. Wat is jullie motivatie om onzelfstandige eenheden te transformeren tot zelfstandige eenheden?
  - a. Is er belang of wens vanuit ouderen? Wordt dit aangevraagd door de ouderen zelf?
3. Hebben jullie al meerdere van dit soort projecten gedaan? Hoeveel woningen?
4. Wat voor type gebouw wordt getransformeerd?
5. Wat is de overweging om te transformeren en niet nieuw te bouwen? Ook qua kosten?
6. Is het transformatie project in samenwerking met gemeente of andere partijen? Krijgen jullie er subsidies voor?

#### **Ouderen**

1. Zijn de woningen in een bewoonde staat wanneer jullie de woningen gaan transformeren?
2. Wat was de huidige staat van de woningen betreft het comfort en binnen klimaat?
3. Was de huidige woning geschikt voor ouderen om langer zelfstandig thuis te kunnen wonen?
4. Welke aanpassing in het gebouw maken jullie zodat ouderen langer zelfstandig thuis kunnen blijven wonen?
  - a. Zitten hier obstakels/moeilijkheden in?
  - b. Zorg technologieën, welke worden toegepast?
    - i. Is dit op aanvraag? Wordt dit geleend?
5. Hoe verloopt het proces met ouderen huurders, betreft de communicatie en participatie?
  - a. Tijdelijke woning?
  - b. Weerstand?
6. Realiseren jullie ook sociale voorzieningen en faciliteiten in de omgeving? Of door middel van samenwerkingen?

#### **De woningen / proces**

7. Moet de woning aan bepaalde eisen voldoen om getransformeerd te kunnen worden?
8. Zijn er fysieke barriers bij zo'n transformatie project?
9. Zijn er organisatorisch obstakels voor het transformeren van woningen waar jullie tegen aan gelopen zijn?
10. Zijn er obstakels in samenwerkingen met andere organisaties/partijen in het transformatie project?
11. Met welke aspecten moet rekening gehouden worden met transformatie projecten voor ouderen?

#### **Energie/renovatie**

12. Worden de woningen energetisch verbeterd in het transformatie project?
13. Welke niveau van comfort kunnen de ouderen verwachten, en welk comfort level in wenselijk voor deze doelgroep?
14. Wat is de feedback van bewoners na het transformatie project?

#### **Tops**

15. Wat gaat er goed in het proces?

#### Negatief / tips

16. Wat gaat er nog niet goed in het proces? Wat moet er verbeterd worden of oplossingen naar gezocht worden?

#### Tops from email:

17. Om zorgvastgoedprojecten goed van de grond te krijgen is samenwerking tussen verschillende partijen van groot belang. Kunt u dit nader toelichten?
18. Urgentie moet gevoeld worden. Kunt u dit nader toelichten?
19. Onzelfstandige eenheden zijn niet meer van deze tijd. 2-Kamer is eigenlijk wel van deze tijd (het minimum). Kunt u dit nader toelichten?

#### Tips from email:

20. Ouderenzorg is echt een vak apart, een gemiddelde woningcorporatie heeft geen idee wat er nodig is. Kunt u dit nader toelichten?
21. Tenminste energieneutraal, TCO als leidend criterium

Geïnformeerde toestemming

Delft, 2-5-2024

Geachte mevrouw Schaafsma,

Dit interview is onderdeel van een master thesis onderzoek aan de TU Delft naar het integreren van voorzieningen voor ouderen om langer zelfstandig te kunnen wonen in renovatie projecten van woning corporaties in Nederland. Woning corporaties worden verwacht de leiding te nemen in de energie transitie van de huidige gebouwde omgeving. Naast deze grote uitdaging wordt de vraag naar geschikte ouderen woningen ook groter door de vergrijzing. Om op beide vragen in te spelen, kijkt dit onderzoek naar de integratie van deze twee vraagstukken.

Dit onderzoek wordt uitgevoerd door Willemijn Vos met twee mentoren die het onderzoek begeleiden Angela Greco and Queena Qian.

U bent niet verplicht om mee te doen aan het onderzoek. U kunt altijd uw medewerking aan het onderzoek zonder opgaaf van redenen intrekken en vragen om uw gegevens te vernietigen. U mag ook iedere vraag die wij stellen weigeren te beantwoorden. Wij beloven zorgvuldig met uw gegevens om te gaan en dat de gegevens op een beveiligde Europese server bewaard worden met een password voor extra beveiliging.

Als u vragen heeft over dit onderzoek kunt contact opnemen

Als u mee wilt doen aan dit onderzoek, wilt u dan de bijgaande verklaring invullen en ondertekenen?

Met vriendelijke groet,

Willemijn Vos

(1) Ik verklaar dat ik de informatiebrief d.d. 2-5-2024 heb gelezen of deze brief is aan mij voorgelezen. Ik heb deze informatie begrepen. Daarnaast heb ik de mogelijkheid gekregen om hier vragen over te stellen en deze vragen zijn naar tevredenheid beantwoord

**Ja / nee**

(2) Ik verklaar hierbij dat ik vrijwillig meedoe aan dit onderzoek. Ik begrijp dat ik mag weigeren om vragen te beantwoorden en dat ik mijn medewerking aan dit onderzoek op elk moment kan stoppen zonder opgave van reden. Ik begrijp dat het meedoen aan dit onderzoek betekent dat mijn antwoorden worden bewaard.

**Ja / nee**

(3) Ik begrijp dat het geluidsmateriaal (of bewerking daarvan) en de overige verzamelde gegevens uitsluitend voor analyse en wetenschappelijke presentatie en publicaties zal worden gebruikt

**Ja / nee**

(4) Ik begrijp dat de opgeslagen gegevens onder een code worden bewaard en anoniem worden verwerkt

**Ja / Nee**

(5) Ik geef hierbij apart toestemming dat de geanonimiseerde gegevens in de toekomst ook door andere onderzoekers mogen worden gebruikt

**Ja / nee**

Ik heb dit formulier gelezen of het formulier is mij voorgelezen en ik stem in met deelname aan het onderzoek.

Plaats:

Datum:

\_\_\_\_\_

Volledige naam

\_\_\_\_\_

Handtekening geïnterviewde

Ik heb toelichting gegeven op het onderzoek. Wij verklaren ons bereid nog opkomende vragen over het onderzoek naar vermogen te beantwoorden.

Naam onderzoeker

Willemijn Vos



## We willen graag eerst met u kennismaken

### 2. Hoe oud bent u?

- ☐ Jonger dan 25 jaar
- ☐ 25 - 34 jaar
- ☐ 35 - 50 jaar
- ☐ 51 - 66 jaar
- ☐ 67 - 74 jaar
- ☐ 75 jaar of ouder
- ☐ Zeg ik liever niet

### 3. Met wie woont u in huis?

- ☐ Ik woon alleen
- ☐ Ik woon bij mijn ouder(s)/verzorger(s)
- ☐ Ik woon samen met mijn partner
- ☐ Ik woon samen met mijn partner en kind(eren)
- ☐ Ik woon samen met mijn kind(eren)
- ☐ Ik woon samen met andere mensen (niet mijn ouders, partner of kinderen)
- ☐ Zeg ik liever niet

## We willen graag eerst met u kennismaken

### 4. Heeft u directe burenen?

Dit zijn burenen die tegen uw woning aan wonen.

Meerdere antwoorden mogelijk

- ☐ Ja, die wonen naast mij
- ☐ Ja, die wonen boven mij
- ☐ Ja, die wonen onder mij
- ☐ Nee

### 5. Woont u voor uw gezondheid in een aangepaste woning of heeft u deze nodig?

Meer informatie over onbeperkt wonen vindt u [hier](#).

Meerdere antwoorden mogelijk

- ☐ Zeg ik liever niet
- ☐ Ja, goede verlichting (want ik heb moeite met letters lezen en/of gezichten op afstand herkennen)
- ☐ Ja, minder galn in de kamer (want ik heb een beperkt gehoor en kan mensen slecht verstaan)
- ☐ Ja, brede deuren en verlaagde drempels (voor rolstoel of rollator)
- ☐ Ja, verhoogde toiletpot, wandbeugels of (inloop)douche
- ☐ Ja, een traplift
- ☐ Ja, slaap- en badkamer verplaatsen naar de begane grond
- ☐ Ja, gasfornuis vervangen door elektrisch koken (vanwege vergeetachtigheid)
- ☐ Ja, verlaagd of verhoogd aanrechtblad
- ☐ Anders, namelijk:

- ☐ Nee

### 6. Wat vindt u belangrijk in uw woning?

Zet op volgorde van meest belangrijk naar minst belangrijk. Doe dit door elk onderdeel een cijfer van 1 t/m 7 te geven of door met uw muis de balkjes naar onderen of boven te verslepen.

- ☐ Veilig wonen (inbraak, brand of letsel)
- ☐ Gezond & comfortabel wonen (daglicht, geluid, luchtkwaliteit, temperatuur of tocht)
- ☐ Energiezuinig wonen
- ☐ Gebruik van duurzame materialen
- ☐ Nette/onderhouden woning: aan [buitenzijde](#)
- ☐ Nette/onderhouden woning: aan [binnenzijde](#)
- ☐ Kwaliteit badkamer, keuken en toilet

## Uw ervaringen ná de renovatie

### 9. Welke klachten heeft u in uw gerenoveerde woning?

Vul alstublieft alle vragen in.

	Ja	Nee	Weet ik niet
Geluid van buiten (verkeer, praten, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Geluid van burens	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Geluid vanuit de gang of het trappenhuis (lopen of praten)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Geluid van installaties (zoals ventilatie)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Te warm in de woning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Te koud in de woning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tocht	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vocht en schimmel	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Niet genoeg frisse lucht in de woning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Slecht werkende scharnieren, sloten en grendels van deuren en ramen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
De installaties zijn lastig te bedienen (verwarming en ventilatie)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
De installaties werken niet goed (verwarming en ventilatie)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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## Plan Overview

*A Data Management Plan created using DMPonline*

**Title:** A structured approach to evaluate and align renovation and aging in place needs for social housing

**Creator:** Willemijn Vos

**Principal Investigator:** Willemijn Vos

**Data Manager:** Willemijn Vos

**Affiliation:** Delft University of Technology

**Template:** TU Delft Data Management Plan template (2021)

### **Project abstract:**

Globally, the population is aging resulting in a large group of elderly people and not enough health care employees to take care of this group. Aging in place, the goal for older individuals to age in their homes, is considered vital for their quality of life and to unburden the healthcare facilities. The demand for age-friendly residences is growing, necessitating a proactive approach to renovating homes for the elderly. Housing associations are expected to take the lead in the energy transition of the existing building stock and need to renovate their portfolio to meet the energy requirements. Integrating aging in place features in the renovations plans of housing associations can help motivate elderly to cooperate and approve of these plans, since 70% approval need to be reached. This research will answer the question: how can aging in place features be integrated in energy renovations of social housing in The Netherlands? This will be researched through a literature study, interviews with housing associations, scenario planning and a focus group. The goal is to balance the needs for aging in place and energy improvement renovation project to maximize the impact for the housing association and the elderly. The deliverable of this master thesis is a structured approach to balance energy renovation and aging in place needs for social housing.

**ID:** 141449

**Start date:** 12-02-2024

**End date:** 05-07-2024

**Last modified:** 06-05-2024



# A structured approach to evaluate and align renovation and aging in place needs for social housing

## 0. Administrative questions

1. Name of data management support staff consulted during the preparation of this plan.

My faculty data steward, Janine Strandberg, has reviewed this DMP on 12 january 2024.

2. Date of consultation with support staff.

2024-01-12

## I. Data description and collection or re-use of existing data

3. Provide a general description of the type of data you will be working with, including any re-used data:

Type of data	File format(s)	How will data be collected (for re-used data: source and terms of use)?	Purpose of processing	Storage location	Who will have access to the data
Qualitative interview data	.docx files	Interviews with portfolio manager, asset manager and operational manager of a social housing association	To understand the opportunities and barriers when integrating aging in place improvements in energy renovations on the strategic, tactical and operational level	personal TU Delft onedrive	The project team, this includes Willemijn Vos, Angela Greco and Queena Qian
Qualitative interview data	.docx files	Interviews with social housing tenants with the age above 65 years old	To understand the needs and preferences of the aging social tenants regarding aging in place	personal TU Delft onedrive	The project team, this includes Willemijn Vos, Angela Greco and Queena Qian
Qualitative data from case study	.docx files	Expert interview with real estate manager of housing association and elderly care and home provider	To learn the do's and don'ts from initiatives to integrate aging in place improvements in energy renovations	personal TU Delft onedrive	The project team, this includes Willemijn Vos, Angela Greco and Queena Qian
Strategy set	.docx files	Expert interview	To find strategies that overcome the barriers when integrating aging in place improvements in energy renovations	personal TU Delft onedrive	The project team, this includes Willemijn Vos, Angela Greco and Queena Qian

4. How much data storage will you require during the project lifetime?

- 250 GB - 5 TB

## II. Documentation and data quality

5. What documentation will accompany data?

- Methodology of data collection

### III. Storage and backup during research process

6. Where will the data (and code, if applicable) be stored and backed-up during the project lifetime?

- OneDrive

### IV. Legal and ethical requirements, codes of conduct

7. Does your research involve human subjects or 3rd party datasets collected from human participants?

- Yes

8A. Will you work with personal data? (information about an identified or identifiable natural person)

*If you are not sure which option to select, first ask your [Faculty Data Steward](#) for advice. You can also check with the [privacy website](#) . If you would like to contact the privacy team: [privacy-tud@tudelft.nl](mailto:privacy-tud@tudelft.nl), please bring your DMP.*

- Yes

8B. Will you work with any other types of confidential or classified data or code as listed below? (tick all that apply)

*If you are not sure which option to select, ask your [Faculty Data Steward](#) for advice.*

- No, I will not work with any confidential or classified data/code

9. How will ownership of the data and intellectual property rights to the data be managed?

*For projects involving commercially-sensitive research or research involving third parties, seek advice of your [Faculty Contract Manager](#) when answering this question. If this is not the case, you can use the example below.*

The datasets underlying the published papers will be publicly released following the TU Delft Research Data Framework Policy. During the active phase of research, the project leader from TU Delft will oversee the access rights to data (and other outputs), as well as any requests for access from external parties. They will be released publicly no later than at the time of publication of corresponding research papers.

10. Which personal data will you process? Tick all that apply

- Data collected in Informed Consent form (names and email addresses)
- Signed consent forms

11. Please list the categories of data subjects

Asset manager and operational managers of a housing association in The Netherlands. Moreover, aging social tenants of the same

housing association. Employee of the municipality, with experience as a portfolio manager. Two real estate managers in housing for elderly

**12. Will you be sharing personal data with individuals/organisations outside of the EEA (European Economic Area)?**

- No

**15. What is the legal ground for personal data processing?**

- Informed consent

**16. Please describe the informed consent procedure you will follow:**

All study participants will be asked for their written consent for taking part in the study and for data processing before the start of the interview. The informed consent will be emailed with the interview protocol a week before the interview is planned, so that the participants can read it beforehand.

**17. Where will you store the signed consent forms?**

- Same storage solutions as explained in question 6

**18. Does the processing of the personal data result in a high risk to the data subjects?**

If the processing of the personal data results in a high risk to the data subjects, it is required to perform [Data Protection Impact Assessment \(DPIA\)](#). In order to determine if there is a high risk for the data subjects, please check if any of the options below that are applicable to the processing of the personal data during your research (check all that apply).

If two or more of the options listed below apply, you will have to [complete the DPIA](#). Please get in touch with the privacy team: [privacy-tud@tudelft.nl](mailto:privacy-tud@tudelft.nl) to receive support with DPIA.

If only one of the options listed below applies, your project might need a DPIA. Please get in touch with the privacy team: [privacy-tud@tudelft.nl](mailto:privacy-tud@tudelft.nl) to get advice as to whether DPIA is necessary.

If you have any additional comments, please add them in the box below.

- None of the above applies

**22. What will happen with personal research data after the end of the research project?**

- Personal research data will be destroyed after the end of the research project

## **V. Data sharing and long-term preservation**

**27. Apart from personal data mentioned in question 22, will any other data be publicly shared?**

- All other non-personal data (and code) produced in the project

**29. How will you share research data (and code), including the one mentioned in question 22?**

- All anonymised or aggregated data, and/or all other non-personal data will be uploaded to 4TU.ResearchData with public access

**30. How much of your data will be shared in a research data repository?**

- < 100 GB

**31. When will the data (or code) be shared?**

- At the end of the research project

**32. Under what licence will be the data/code released?**

- CC0

## **VI. Data management responsibilities and resources**

**33. Is TU Delft the lead institution for this project?**

- Yes, the only institution involved

**34. If you leave TU Delft (or are unavailable), who is going to be responsible for the data resulting from this project?**

The Head of the Department of the Best Experiments (hod-bestexperiments@tudelft.nl)

**35. What resources (for example financial and time) will be dedicated to data management and ensuring that data will be FAIR (Findable, Accessible, Interoperable, Re-usable)?**

4TU.ResearchData is able to archive 1TB of data per researcher per year free of charge for all TU Delft researchers. We do not expect to exceed this and therefore there are no additional costs of long term preservation.