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Optimizing public space design at the daily walking route for the older population

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Optimizing public space design at the daily walking route for the older population

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(TheColorFully, 2012)

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Preface

This thesis is written within the research project of ‘public spaces for happy senior living’, in collaboration with TU Delft and TU Eindhoven (Ontwerp en overheid , 2020). Being able to combine the results of this research with existing research was a really interesting approach to me, as it allowed me to focus on a small area within a bigger framework. I was therefore able to combine my interests of the preferences and effects of public space design with some psychological topics, like mental well-being.

I really enjoyed doing this research and going into depth of a lot of new topics and learning new skills. Setting up the experiment with visualizations was definitely a challenge, but it also was a really interesting process from which I have learned a lot. Similarly, the analysis of the results was difficult at times, but it also was really great to see how the results can be translated into something that can be used in practice.

I would like to thank my academic supervisors Ioulia Ossokina, Birgit Jurgenhake, and Theo Arentze for their guidance and feedback throughout this project. They encouraged me to take the research to a higher level and were always there to answer my questions. Furthermore I would like to thank Taanis Karigar, who helped me with the R Studio script. And finally, I want to thank my family and friends for their support.

Abstract

With the increasing elderly population worldwide, the concept of 'active ageing' becomes more important. This concept implies that health, participation and quality of life should be optimized in the third age. This is not only important within the homes where older people live, but in their whole living environment. As individuals age, new physical and social needs emerge. First of all, the ageing process may reduce their functional capacity resulting in everyday tasks like grocery shopping becoming a challenge. Besides the physical needs, smaller social network due to, among other things, retirement, may result in loneliness and connected social needs. Within the current built environment, these specific needs that come with the ageing process, are not integrated sufficiently yet, and thus there arises a research question of: *How can the design of existing public spaces be improved to stimulate daily outside activity of older people, based on their preferences of physical and social needs?*

To answer the research question, first an elaborated literature review was conducted on the physical and social needs of older people and how these are currently integrated in public space design. When discussing the physical needs, a scale from physical accessible to physical comfortable attributes of public space was suggested in this thesis. Physical accessibility refers to issues like height differences, pathway deformations, obstructions and lack of resting points, that might prevent older people from utilizing a public space. Physical comfort refers to those attributes that reduce comfort and might make seniors more reluctant to enter a public space, such as perceived safety or atmosphere. When discussing the social needs, a scale from social interactive to social emotional attributes of public space was suggested in this thesis. Social interactive public space design can help reduce loneliness as social interaction is stimulated. For social emotional public space design, the concept of 'restoration' is important. Stressful or busy situations, such as every-day life work or other activities can cause mental fatigue, as one constantly has to force him/herself to pay attention. A restorative environment reduces this mental fatigue. Nature is one of those environments that has high restorative value, and has proven to reduce stress and improve mental wellbeing.

To find out which attributes of the public spaces, physical or social emotional, are most effective in stimulating outside activity of older people in existing built environment, a stated choice experiment was executed. More than 400 Dutch people aged 65 and over, have participated in an online experiment, selecting between alternative routes to take when walking to the supermarket or when walking for recreation. The routes varied on 5 attributes: (i) the length of the walk, later used to define the willingness to walk; (ii) 3 physical attributes namely; pathway type, pathway width, and presence of bench on the route, and (iii) a social-emotional attribute of a green restorative environment.

Since it might be difficult to imagine what the combination of certain attributes might look like in real life, visualizations were used to describe the routes. One of the most important aspects while creating the images was to make each of the attributes as prominent as the others, so there is no bias in level of importance. This was done using photo-realistic images, as input from seniors themselves showed that those were easiest and quickest to understand.

Different econometric models (multinomial logit, latent class, OLS, etc.) were estimated to analyse the outcomes of the experiment. Results suggest that the green restorative environment has a high importance for older people; if a route goes through a green environment, seniors are on average willing to walk an extra 10 minutes. For the physical attributes, pathway type was found most important, in which a smooth regular surface like asphalt resulted in a higher willingness to walk of 10 minutes. Results showed further a high degree of heterogeneity within the group of older people. Especially those seniors that have any type of mobility restriction or those that face loneliness or low life satisfaction are less willing to walk and prefer relatively shorter distances. The optimization of physical attributes could increase the willingness to walk, especially with the addition of benches or the green environment. However, more research is needed to find out what the effect of a restorative environment is for this specific group of people.

Finally, the insights from the research were processed into a toolbox that can be used to evaluate and optimize current walking routes for older people. The toolbox can be seen as an extension of the toolbox suggested by Ossokina and Jurgenhake (2021) in their paper ‘Inclusive public spaces for happy senior living’.

Future research might expand the current set of attributes by also including physical comfortable needs and social interactive needs that were researched in the literature review. Furthermore, restoration in the built environment could be studied in more detail, as not much is known yet about the restorative value of other attributes such as entropy, flow of people, or street art for example. Finally, the heterogeneity of the elderly target group needs further investigation, especially by doing more research on the needs and preferences of elderly with physical and social impairments.

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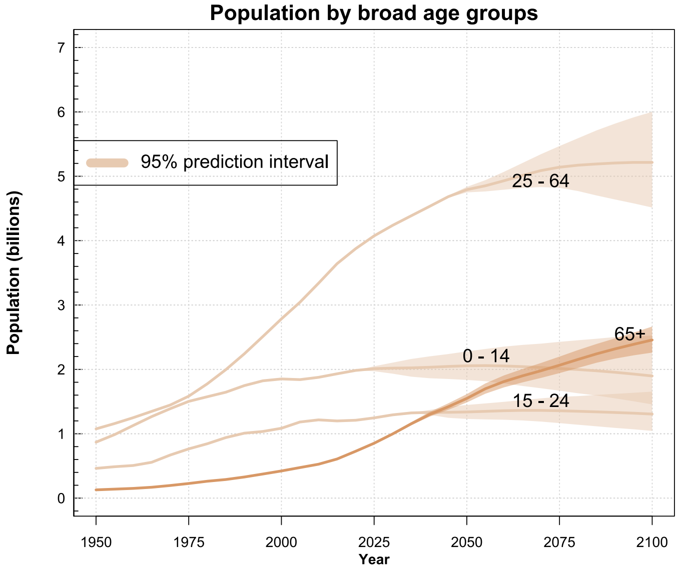
1. Introduction

1.1 ACTIVE AGEING

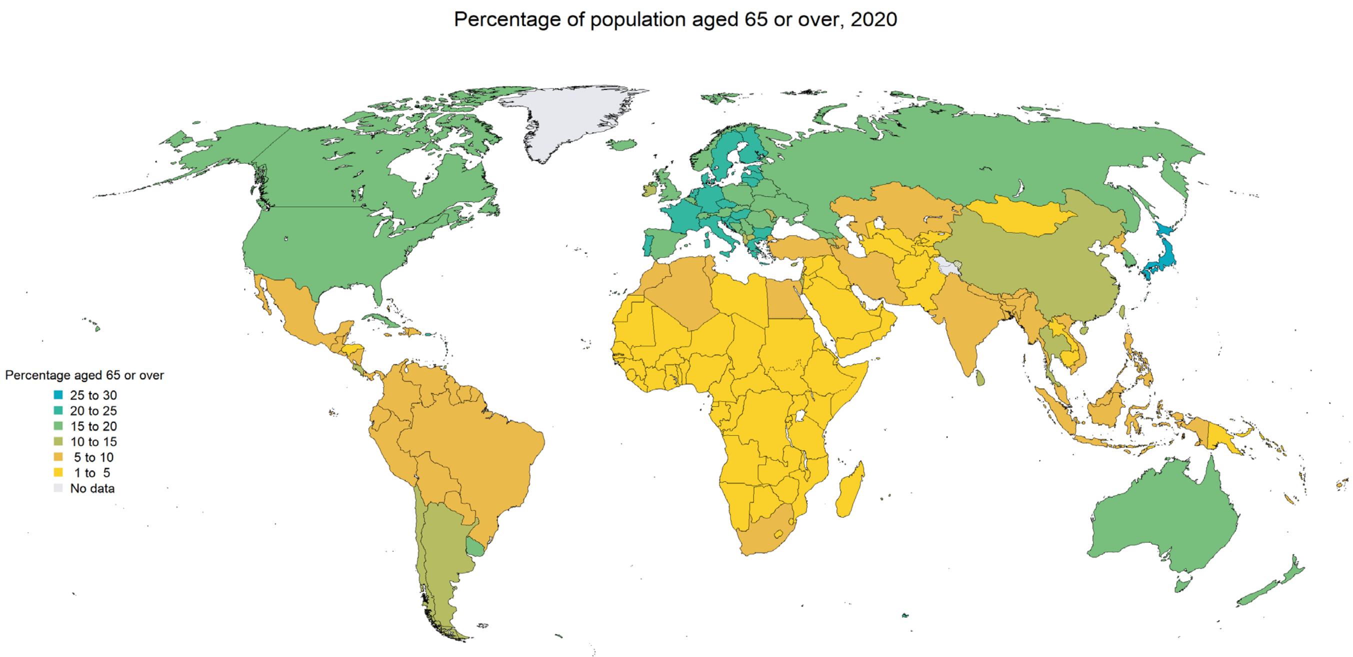
Many countries are affected by the demographic change of ageing. Even though the whole European population is expected to increase, the group of elderly is expected to grow even more, caused by the increased life expectancy and low birth-rates (European Commission, 2016). Figure 1 shows how much the age group of 65+ increases in comparison to the other age groups worldwide. In 2019 the percentage of the age group of 65+ was 9.1%, and will increase to 15.9% by 2050 (United Nations, 2019c). Figure 2 shows that the 'richer' countries in the world have the highest percentages of elderly. Especially in (West) Europe (and Japan), the percentages are already very high. In 2020 the amount of elderly in Europe is already 19.1% and will increase to 28.1% by 2050 (United Nations, 2019c).

Figure 1_ Population forecast



Source: United Nations (2019c)

Figure 2_ Percentages of population aged 65 and over



Source: United Nations (2019c)

As the life expectancy increases and there will be more elderly, the concept of 'active ageing' is becoming more important, as it focusses on the improvement of the quality of life of the elderly population (World Health Organization, 2002). As the World Health Organization stated in 2002:

"Active ageing is the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age."

- (World Health Organization, 2002).

As elderly grow older, their functional capacity will decrease caused by the ageing process. Mobility restrictions and frailty are caused by a weaker immune system, cardiovascular diseases, and problems with joints and connective tissue (Clegg et al., 2013). But also visual impairments (Clegg et al., 2013), hearing impairments (Katayama et al., 2021), or cognitive impairments such as dementia (Blackman et al., 2003) can reduce the quality of life for elderly. And the older people get, they are also more likely to experience multiple health issues at the same time. These restrictions lead to different needs for elderly in their daily lives as they are not always able to perform every day-tasks anymore (CBS, 2015).

Furthermore, elderly find themselves in the life cycle stage that is defined by retirement and death of friends and partners, causing a smaller social network. This leads to an increasing challenge among the older population of loneliness and social exclusion (Holmén et al., 2000) and can result in negative effects on their overall health and mental well-being (Doménech-Abella et al., 2017).

With the changing world demographics of ageing, and the issues that come with the ageing process such as decrease of functional capacity and a smaller social network, there should be more attention to improving active ageing.

1.2 POLICIES FOR ACTIVE AGEING

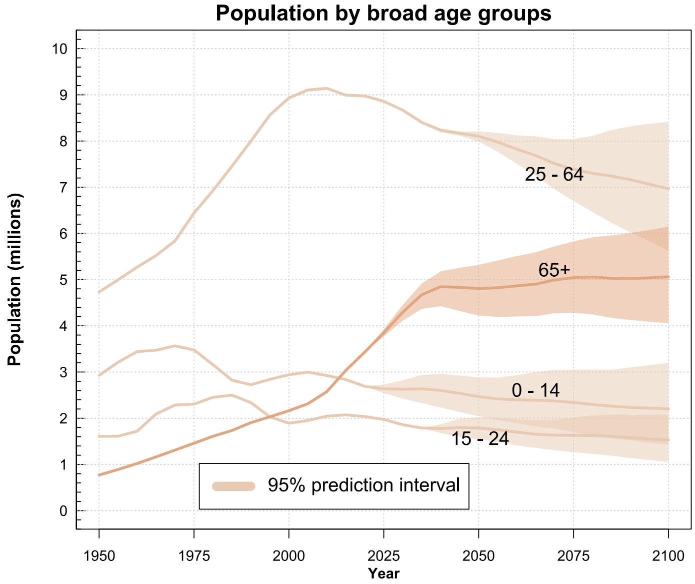
In order to improve active ageing globally, the World Health Organization (WHO) created the 'Global Strategy and Action Plan on Ageing and Health'. The plan includes long-term health systems designed around the needs and preferences of elderly in all countries to create age-friendly environments (World Health Organization, 2017). According to the Global Institute (2016), there are four principles that guide cities into creating these age-friendly environments. First of all, an infrastructure should be created that accommodates all citizens of every generation; proper housing should be provided allowing elderly to age in place and live independently; community programs should be created to enhance social cohesion; and finally, opportunities should be created for work, education and recreation (Global Institute, 2016). The United Nations also created some policies and recommendations to improve active ageing, but they also emphasize the fact that there is no one policy response that can be used for all countries (United Nations, 2019b).

Since Europe deals with very high levels of elderly already (figure 2), the European Commission also created multiple policies to improve active ageing in Europe (European Commission, 2016). For example the guiding principles for active ageing that were established in 2012 with focus points on employment, participation in society (and social inclusion), and independent living (Council of Eruopean Union, 2012).

1.3 ACTIVE AGEING IN THE NETHERLANDS

However, policies for active ageing are needed on smaller (national and local) scales as well, since quality of life is also dependent on national characteristics (culture), local characteristics (neighbourhood and community), and personal characteristics (gender, ethnicity, socio-economics, etc.) (World Health Organization, 2018). As explained before, highest levels for elderly can be found in Western Europe. Therefore this research is focused on such Western-European country, namely the Netherlands. Figure 3 shows the population forecast of the Netherlands, which has a very steep increase of elderly in the upcoming 30 years. So, policies for active ageing become even more important.

Figure 3_Population forecast of the Netherlands



Source: United Nations (2019c)

The Netherlands already recognized the issues that come with the increasing ageing population, and already implemented several policies and programs. An example of such program is “Langer Thuis” which encourages elderly to live in their homes longer (Rijksoverheid, 2018). The reason to stimulate longer independent living for elderly is related to the concept of ‘ageing in place’, in which people want to live in their own homes as long as possible to remain independent and to be physically closer to their social network of friends and family (Wiles et al., 2011). Other national programs include an initiative called ‘Eén tegen eenzaamheid’, tackling issues of loneliness among elderly. In collaboration with local municipalities and the national government, activities are organized to decrease loneliness and increase social contacts for elderly (Ministerie van Volksgezondheid, Welzijn en Sport, 2018). However, statistics show that in the Netherlands, 50% of the age group over 65 still feels socially lonely (De Staat van Volksgezondheid en Zorg, Eenzaamheid, 2016), and roughly 35% is depressed (De Staat van Volksgezondheid en Zorg, Depressie, 2019). There should therefore be more attention to the mental well-being of this age group.

1.4 SENIOR-FRIENDLY ENVIRONMENTS

As mentioned before, the WHO strives for age-friendly environments. Besides the improvement of the homes of elderly, this also includes the public space surrounding their living environment. Important aspects for the creation of age friendly environments in public open spaces are created by WHO in 2007 and include: pleasant and clean environment, importance of green spaces, resting places, age-friendly pavements, accessibility, safety and services (World Health Organization, 2007). According to Yung et al. (2016) public open space can enhance active ageing and the social well-being of elderly, and Sugiyama et al. (2009) stated that the quality of life for elderly will be positively impacted by the outdoor environment, resulting in better health and mobility. So in order to improve active ageing, elderly should have access to public outdoor spaces.

In this respect, urban green spaces, such as parks, are often considered as a mean to reduce health issues and stimulate social interaction for the elderly (Yung et al., 2016). Enssle & Kabisch (2020) for example found that with higher frequency of visiting green space, the health status and social network of elderly is positively influenced. Furthermore, Zhou & Rana (2012) also explored the social benefits that urban green spaces generate and Wan et al. (2021) found a direct positive relationship between the physical characteristics of green spaces and social cohesion. These positive influences of green environments on the mental wellbeing are related to the concept of ‘restoration’, where a restorative environment can help reduce mental fatigue, reduce stress, and improve mental well-being (Kaplan & Kaplan, 1989; Ulrich et al., 1991), which is often found in these green environments.

However, Enssle & Kabisch (2020) showed that only a quarter of the elderly participants visited public green spaces on a daily basis. Moreover, 23% of the participants in this study visited public green space less than once a month or not at all. In the Netherlands, the elderly over the age of 65 go on a stroll only once or twice a week on average (CBS, 2020). So when improving daily walking routes within the framework of age-friendly environments, elderly could be stimulated to use active modes of transport, such as walking, more often. Optimizing these public spaces could then contribute to a more all-inclusive space that promotes active ageing. In this study I will therefore focus on how to make public spaces more age friendly.

1.5 SENIOR PREFERENCES

According to Jan Gehl (2011), outdoor activities can be divided into three categories; necessary activities, optional activities, and social activities. For necessary activities, accessibility and all-inclusive public space design are essential, as there is a need to execute the activity. Being able to execute such activity is defined by physical capacity that determines the accessibility, depending on pathways, resting points, height differences, etc., but it is not limited to physical factors only. When a public space is not designed in a clear and structured way, way-finding becomes very difficult. Especially for elderly with cognitive impairments it becomes a functional barrier. Nonetheless, in this report, the needs that elderly have to execute necessary activities will be called ‘physical needs’. For social or optional activities on the other hand, physical needs are still essential, but the social needs of elderly should be met as well, as they might influence the frequency of executing these activities. Social needs are about those design factors that provide restoration and elongate the willingness to stay in order to improve mental well-being. Atmosphere plays an important role for those social needs of elderly, as it can create feelings of comfort, safety, pleasantness and restoration. A resting place can for example meet the physical needs when just providing a place to rest for a short period of time. But when comfort is increased by optimizing the view, shape, composition, location, and overall atmosphere of the seating area, a social need might be met as well.

Many researchers have focused on the physical aspects of public space design for elderly, such as accessibility(Boenke & Schreck, 2014; White et al., 2015; Ferreira & Sanches, 2007; Ståhl et al., 2008), or walkability (Moura et al., 2017; Borst et al., 2009). Other researchers mainly focused on the social aspects of public space design for elderly (Swart et al., 2009; Enssle & Kabisch, 2020; Rad & Ngah, 2013). There have been some researches that included both physical and social aspects of public space design, but these researches tend to focus only on public spaces that either have a necessary function, such as pathways for transport (Aspinall et al., 2010), or a social or optional function, such as parks (Alves et al., 2008).

In this report, the combination of those physical and social needs of elderly will be investigated in public space design. The research question of this report therefore is:

How can the design of existing public spaces be improved to stimulate daily outside activity of elderly, based on the preferences of the physical and social needs of the seniors?

In order to answer this research question, first a literature research is done in which the following sub-questions will be answered.
1. What are the restrictions (physical or others) that come with the ageing process?
2. What are the physical needs of elderly in public spaces?
3. What are social needs of elderly in public spaces?
4. How are physical and social needs of elderly implemented in current public space design?

After the literature review, a stated choice experiment will reveal the answers to the following sub questions:
5. Which attributes (and attribute levels) of public spaces are preferred by elderly?
6. What is the relative impact of social and physical factors on the preferences of elderly?
7. Can the physical or social preferences of elderly be further explained by individual factors such as mobility restrictions or age?

This report will start with an elaborated literature review to establish the physical and social needs of elderly and how this is integrated in current space design. Based on this literature and some (informal) interviews, a longlist of the most important attributes of public space design for elderly is established. A stated choice experiment will be used to find the preferences of elderly for specific attributes, explained in chapter 3. Since the stated choice experiment is about public space design, visualizations need to be created. The process of this creation of visualization is explained in a sub experiment in chapter 4. Chapter 5 then continues with the explanation of the data collection through an online survey. Since the experiment consists of two parts, the results are explained in chapter 6 and 7. Chapter 6 focusses on the discrete choice model to find the preferences of elderly in public spaces. With the use of a latent class model, different groups of elderly can be defined with different preferences. Chapter 7 focusses on the Ordinary Least Squares method to find the willingness to walk of elderly for different attributes. In chapter 8, the results of the experiment are translated into an application that can be used to optimize existing public space design for the elderly population. And finally, chapter 9 will end with a conclusion and discussion of this research and gives some suggestions for future research.

2. Literature review

In this chapter the physical and social needs of elderly will be explored through an elaborated literature review. First, some definitions will be given, followed by the social and physical needs of elderly and how urban design solutions can meet these needs. This results in a longlist of the most important attributes of public space design for elderly, which are then discussed further in some informal interviews.

2.1 DEFINITIONS

To understand every aspect of the research question, some terms require some specific definition. First of all, the target group of elderly in this research can be defined as the population with the age of 65 years and older. Furthermore, the focus is on daily outside activity, which in this research will be defined as all outdoor activities related to daily grocery shopping.

A definition of 'urban open space' as described by Francis (1987) is a "publicly accessible open space designed and built for human activity and enjoyment." However public space is a very broad term, and can be interpreted differently. According to Iveson (1998), there are even four models that define 'public space': ceremonial public space; community public space; liberal public space; and multi-purpose public space. Ceremonial public space refers to grand public squares used for events of the nation. Community public space refers to a place that meets people's needs and has meaning. Liberal public space defines a space that is open and accessible to all, with social differences being ignored. And finally, the multi-purpose public space is defined as an universal public space specifically structured for coexistence of multiple publics (Iveson, 1998). In this report public space will be defined as a combination of the community model of public space, that meets people's needs, and the liberal model of public space, that is accessible to all.

In this report, public space is defined as an outdoor space that is publicly accessible to everyone and is owned by the government. This includes all objects on the streets, such as pathways, roads, vegetation, etc.

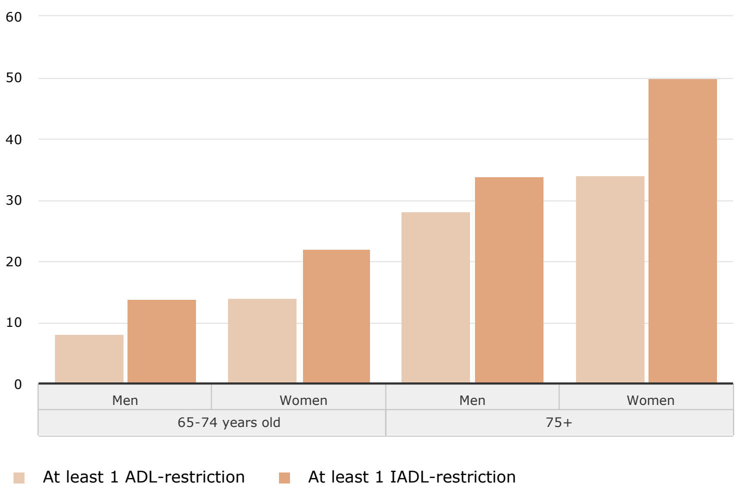
2.2 ELDERLY NEEDS

2.2.1 Physical needs

The age group of elderly is very diverse and cannot be considered as a homogeneous group of people. However with the ageing process also come some challenges with every-day tasks, and the amount of elderly dealing with these challenges increases as they are growing older, shown in figure 4 (CBS, 2015).

[1] ADL= General Daily Life Activities; ADL= Instrumental General Daily Life Activities

Figure 4_ Restrictions of daily tasks of elderly[1]



Source: CBS (2015)

First of all, physical health issues related to the ageing process, such as cardiovascular diseases, problems with joints and connective tissue, and a weaker immune system lead to mobility restrictions of the target group (Clegg et al., 2013). Elderly are often in need of some type of aid, such as a walking stick, a stroller, or even a wheelchair. The walkability of elderly therefore reduces, and they might require additional design features to improve their walkability. An example of these reduced mobility can be found in pavement, as slippery or uneven floors cause problems (White et al., 2015; Australian Human Rights Commissions, 2008), seniors prefer soft or even pavement (Zhai & Baran, 2017).

Other issues in the ageing process are visual impairments (Clegg et al., 2013), which can also lead to mobility issues, since the design of obstacles may form a problem. Elderly generally have more difficulty in perception caused by visual impairments, as it might be more difficult for them to switch between focus on objects, contrasting colours or patterns, and they are more sensitive to glare. Misinterpretation of the situation can be a result of this (The American Institue of Architects , 1985). They may therefore need additional information of their surrounding by means of height differences in the pavement or distinction in ground surfaces (Boenke & Schreck, 2014). Furthermore, elderly may encounter hearing impairment issues (Katayama et al., 2021). Within the built environment this could cause safety problems or social exclusion, as it reduces the ability to communicate (The American Institue of Architects , 1985). Within the ageing process, the hearing gets worse over the years, so being in an calm environment with low background noises becomes more important. Other common problems within the ageing process include cognitive impairments such as dementia. Elderly with dementia can experience problems with disorientation, interpretation or navigation in public spaces, which can then lead to high levels of stress (Blackman et al., 2003).

These different needs of elderly also require different design solutions both in their homes, but also in public spaces. Section 2.2. shows how public space design should be optimized to meet these physical needs.

2.2.2 Social needs

Within the ageing process, age-related changes occur in the brain that increase the risk of the so-called ‘late life depression’. Vitamin B12 and folate for example play a role in this process (Gottfries, 2001). On top of that, reduced social network caused by death of partners and friends also lead to loneliness and social exclusion among elderly (Holmén et al., 2000) and can result in negative effects on their overall health and mental well-being (Doménech-Abella et al., 2017).

The social needs of elderly can be divided into two needs; the first being social interactive needs and the second social emotional needs. The social interactive needs relate to those needs that reduce loneliness. Programs like ‘Langer Thuis’ (Rijksoverheid, 2018) and ‘Eén tegen eenzaamheid’ (Ministerie van Volksgezondheid, Welzijn en Sport, 2018) are focusing on those social interactive needs of elderly. But research has also proven that several design solutions in public space can help increase social cohesion and reduce loneliness among the elderly as well. This topic will be discussed in more details in section 2.4.

Social emotional needs on the other hand are related to the mental wellbeing. When using urban design solutions to improve mental wellbeing, the concept of ‘restoration’ plays an important role. Of course, depression of elderly cannot be cured by creating an restorative environment, but research has proven that restorative environments positively influence the overall mental wellbeing and reduces stress. This will be explained further in section 2.5.

2.3 URBAN DESIGN SOLUTIONS PHYSICAL NEEDS

Many researches have shown how urban design solutions can be implemented to make public spaces more inclusive to the needs of elderly. In general, the design solutions used to improve the physical needs of elderly will also contribute to other social groups including children, people with disabilities, carers of children (with buggies or strollers), but also strangers to the location (Hauderowicz & Serena, 2020). In this section, examples of design solutions will be given of those public space elements that were found to be important for the elderly target group.

2.3.1 Height differences

Within the existing literature, much research has been done on the design solutions for the restrictions that come with the ageing process. A striking observation includes the contradicting needs between some impairments. For example, blind and visually impaired people prefer higher kerbs, since height difference is a clear indication of a transition in infrastructure (Boenke & Schreck, 2014). These height differences and distinctive ground surfaces may help visually impaired people, but they form extra obstacles for people with wheelchairs, strollers or walkers, since they prefer dropped kerbs and smooth surfaces (Boenke & Schreck, 2014). So, the group of visually impaired people and mobility impaired people have contradicting needs and preferences.

Turel et al. (2007) have created some guidelines for height differences in public space design. For ramps, the width should be at least 90 cm, with a slope smaller than 8%. The longer the ramp, the lower the slope should be. Furthermore, pavement height should be a maximum of 15 cm (Turel et al., 2007), and the preferred ramp height is between 6 cm and 12 cm, since it is accessible for both visually impaired people and mobility impaired people (Boenke & Schreck, 2014). Figure 5 shows a badly designed curb on the left and a correct design on the right side, which is all-inclusive.

Figure 5_Example ramp. Left Bad; Right Good

Sources: (left) picture taken by author *(right) (Boenke & Schreck, 2014)*

So, for the optimal urban space design that is inclusive for all, every impairment of elderly should be taken into account, as well as general needs and preferences. The Australian Human Rights commissions (2008) created guidelines of the good, the bad, and the ugly in public space design for visually, mobility, and cognitive impairments, showing examples of how to (and how not to) design public spaces. An example in this study regarding the accessibility of the visually impaired people is the floor surface. Floor surfaces indicate dangerous elements with height differences such as stairs and ramps. A luminous contrast of more than 30% should be implemented. Figure 6 shows the difference, and mistakes like these make the public space not accessible for everyone (Australian Human RIghts Commissions, 2008).

Figure 6_Examples distinctive ground surfaces. Left Bad; Right Good

Sources: (Australian Human Rights Commissions, 2008)

2.3.2 Pavement

In a study done by Borst, et al (2009) about the walkability in a neighbourhood it was shown that more than half of the elderly in the study chose a route longer than the shortest route, caused by problems such as obstacles and discomfort. Slopes and stairs, but also green strips played an important role in the resistance of elderly to choose the shortest route. Research shows that elderly prefer pathways with even or soft pavement (Zhai & Baran, 2017). Especially curbs and slopes are not preferred (Moura et al., 2017), because it requires more effort. For mobility impaired people, especially with a wheelchair or stroller, the longitudinal profile of the pavement is important. According to Ferreira & Sanches (2007), an optimal pavement should have no unevenness, however, unevenness up to 0,5 cm are still acceptable. Furthermore, the maintenance of the surface of pavement is also important. Irregularities such as cracks, (shallow) holes, and deformations by tree roots should be avoided (Ferreira & Sanches, 2007), as shown in figure 7.

Figure 7_ Examples pavement quality. Left Bad; Right Good

Sources: Pictures taken by author

The material use of pavement surfaces is also important. Regular, smooth, and firm materials are preferred. However it cannot be too slippery (Australian Human RIghts Commissions, 2008). Furthermore, grass or other vegetation on the pavement should be avoided. Rough material can be used, including tiles and concrete. However, mosaic patterns or rustic natural stones, shown in figure 8, cause unevenness and are therefore less comfortable (Ferreira & Sanches, 2007).

Figure 8_ Examples pavement surface. Left Bad; Right Good

Sources: Pictures taken by author

According to Gehl (2011), walking demands space, and people should be able to walk freely without being disturbed. Turel et al. (2007) state that the pavement width should be at least 1,50 meters (one-way) to provide sufficient space for all pedestrians. However, there are three aspects that define the preferred width of pavement, namely walking speed, pedestrian volume, and obstacles. First of all, the walking speed of elderly is much lower than the average person (Bollard & Fleming, 2013). So in order for everyone to walk comfortably, there should be enough space for everyone to walk at their own speed, without disturbing one another. This is also related to the pedestrian volume, as with high volumes of pedestrian traffic, the pavement should be wider so people could pass one another. Finally, obstacles on the pavement make the pathway more narrow. Especially people with wheelchairs or strollers experience issues with rotation. Obstacles include benches, vegetation, trash cans, lanterns, signs, bus stops, etc. The optimal 'effective' width of a sidewalk should therefore be between 1,5 m and 2 m, free of obstacles (Ferreira & Sanches, 2007). Figure 9 shows the difference between a good and a bad design of pavement width.

Figure 9_ Examples pavement width. Left Bad; Right Good

Sources: Pictures taken by author

Besides the quality of the pavement, the separation from (motorized) traffic is also important for elderly (figure 10). Cauwenberg, et al (2014) showed that elderly show higher willingness for walking with separation between sidewalk and cycling path. Furthermore, Ståhl et al. (2008) also found that elderly experience problems when bicycles are not separated from pedestrian walkways.

Since elderly have lower walking speeds, these issues extend to the safety at crossings. Intersections or crossings on the street cause safety issues, especially for elderly caused by issues of frailty, cognitive, visual and mobility impairments, and slower walking speeds (Bollard & Fleming, 2013). The best way for elderly to cross a street is with correct ramps, zebra crossing, and street lights. Other options to increase the safety of crossing for elderly would be traffic calming measures to reduce traffic speeds (Michael et al., 2006).

Figure 10_Example separation traffic. Left Bad; Right Good

Sources: Pictures taken by author

2.3.3 Seating

According to a study conducted by Ståhl et al. (2008) 15% of the elderly in that study was not able to walk more than 200 meters without resting. This makes benches in public space essential in order to fulfil the necessary activity of grocery shopping. Curves in a street might make the area more attractive for example (based on theories of entropy), however they also lengthen the distance towards the destination (Michael et al., 2006). So, for the street design of the public space regarding the elderly, either the length should be reduced, or enough resting places should be provided. This is also important for the distance from the parking lot or public transport node towards the entrance of a grocery store for example.

The importance of seating can be found in literature researching needs for elderly in parks, where the most common park activity is sitting and relaxing (Cohen et al., 2009; Zhai et al., 2018). Cauwenberg, et al (2014) also showed that elderly show higher willingness to walk with the presence of benches. Most complaints on current seating in parks and shopping areas include lack of comfortable seating (Zhai et al., 2018), not enough seating is provided (Lesakova, 2016; White et al., 2015; Michael et al., 2006), low quality of seating (White et al., 2015), and the placement of seating. The latter is explained by Gehl (2011), using the 'edge effect', which means that people prefer to sit along facades or other spatial boundaries and not in the middle of a space. Having the opportunity to see events in the area is the main factor for determining a sitting place (Gehl, 2011; Aspinall et al., 2010; Francis, 1987). Figure 11 shows these differences of seating locations.

Figure 11_Example seating location. Left Bad; Right Good

Sources: Pictures taken by author

Besides the location, the quality of seating is also important. Gehl (2011) mentioned that elderly need primary seating (actual benches), and not secondary seating (so other forms of seating). For other age groups sitting on stairs, or on a wall for example is sufficient, but elderly seek for better quality. According to Mumcu & Yilmaz (2016), elderly show preference for wooden benches with both armrests and backrests in order for them to sit comfortable and to be able to get up easily, shown in figure 12.

Figure 12_Examples seating quality. Left Bad; Right Good

Sources: Pictures taken by author

2.3.4 Weather conditions

Since the Dutch weather conditions can change quickly, protection against wind and rain are preferred. Most literature discussing the needs and preferences of elderly touch the subject of protection against weather conditions lightly, of which most refer to the preference of walking or sitting in the shade (Zhai & Baran, 2017; Enssle & Kabisch, 2020; Aelbrecht, 2016; Wang & Rodiek, 2019). Aalbrecht (2016) for example mentions that people feel more comfort for stationary activities in locations where they feel safe, such as in the shade. So besides the protection against climate conditions, the provision of shade will also contribute to feelings of safety and comfort. Several elements play a role in this. First of all, sun and shading. According to Whyte (1980), the quality of staying will increase when there is sun, as it provides both light and warmth. As for the light of sunrays, people prefer to have a choice between sun, shade, or in-between. Since sun light can cause glare which can be uncomfortable. Trees can provide such in-between space, where there is both light and shade. For the warmth of the sun, the most important aspect is the relative warmth. Especially on colder days, people prefer to sit or walk where the sun radiates, as it will feel warmer (Whyte, 1980). Furthermore, Whyte (1980) also emphasizes that wind, or actually the absence of wind and drafts, might be as important to people as the sun. Drafts can be very uncomfortable. So, according to Whyte, public spaces function best when they are enclosed on three sides to prevent drafts (Whyte, 1980).

2.3.5 Visibility

In section 2.1.2 about restrictions for elderly, it was already mentioned that a very common issue in the ageing process is dementia. It is important to note that not every elderly person might have the diagnosis of dementia, but might still experience forgetfulness or confusion, as dementia comes in stages (Blackman et al., 2003). It is therefore important for elderly to create a clear environment with good visibility. Accessibility does not only include physical accessibility, but also visual accessibility (Rad & Ngah, 2013; Gehl, 2010). Varna & Tiesdell (2010) also emphasize the importance of an inclusive design with connectivity and visual access. A study by Wang & Rodiek (2019) about park attribute preferences showed that elderly will always prefer good visibility, where they can see all activities very clearly.

2.4 URBAN DESIGN SOLUTIONS SOCIAL INTERACTIVE NEEDS

Many design features could play a role in the stimulation of social interaction in a public space. According to Aalbrecht (2016), important elements of public spaces consist of thresholds, pathways, and props. First of all, thresholds are the spaces that form the transition between public and private spaces. In order to stimulate social interaction in these areas, enough space should be created for stationary activities. The longer the duration of the stationary activity, the more space is required. The provision of comfort and privacy is also important, which can be required by closed edges or sunshade areas. Secondly, pathways are important for active and passive activities, such as walking, strolling, or standing (pausing). A pathway can either guide people's movement, or it can function as a guide for walking speed. Finally, props could increase social interaction when used in the right spatial placements (Aelbrecht, 2016). Using this theory as a guideline, the following attributes can play an important role in the stimulation of social interaction:

2.4.1 Bench composition

The social purpose of seating provides a place where people stay in that area for a longer period of time and get the opportunity to socialize with other people. In a study conducted by Swart et al., (2009) about seating for social interaction of elderly in the Netherlands, it became clear that the location of the seating is the most important, followed by accessibility, interaction with other users, comfort of seating, vegetation and maintenance. For the location of seating: it should be in an active location with an interesting view. This is in line with the “edge effect” of Gehl (2011), that is also based on the attractive view that people seek for. The shape or composition of the seating can then influence the level of social interaction. The study of Swart et al., (2009) found that the semi-circular bench with and armrest, to provide private space, is the best type of bench to stimulate social interaction. Jan Gehl explains why such shape is preferred in his book Cities for people (2010). In order to stimulate social interaction while resting in a public space, a “talkscape” should be designed. With long even benches, people cannot see each other without turning their heads, so conversation gets more difficult. So the long bench is designed for privacy and distance (figure 13 left). When the talkscape is used, the benches are grouped (figure 13 right). The architect Ralph Erskine (1914- 2005) created the optimal talkscape, in which two benches are placed at an angle with a table in between, which allows for conversation. Since the benches are set up at a slightly open angle, people can decide whether they want to sit alone or together (Gehl, Cities for people, 2010).

Figure 13_Examples seating location. Left Bad; Right Good

Sources: Pictures taken by author

2.4.2 Atmosphere

In a research done by Mysyuk & Huisman (2019), it was found that elderly seek for tranquillity, peace, beauty, memories and meaning in their living environment. In order for a place to become meaningful, Gehl (2011) argued that only “on foot” an individual will feel at ease and is able to take time to pause, experience, and become involved in the situation. This highlights the importance of traffic speeds for interaction, especially since elderly with impairments might have different speeds as well. Gehl (2011) also mentioned that high levels of activity in a public space can encourage individuals to stay even longer.

For the visual impairments of the ageing process, it was found that illuminance levels should be three times higher for people over the age of 60 compared to the average 20 year old (Kunduraci, 2017). This is especially important when considering the social aspect of public spaces. In order to stimulate social interaction, lighting should illuminate people's faces (Kunduraci, 2017). Gehl (2011) confirms that by stating that adequate lighting should be towards horizontal surfaces, such as faces, walls, street signs, mailboxes etc. And in order to see facial expressions, the maximum distance between people should be 20 to 25 meters, and that for good public space design, dimensions should not exceed 110 meters.

Furthermore, Angell et al., (2012) argued that besides lighting also appropriate colours, sounds and scent can influence the atmosphere of an environment.

2.4.3 Greenery
Multiple studies found positive influences of green spaces on social integration for the elderly population (Kweon et al., 1998; Enssle & Kabisch, 2020). Wang & Rodiek (2019) for example argue that in order to stimulate social interaction, a combination of trees, grass and colourful flowers can be used. Trees in general can be used to stimulate social interaction since they offer comfort, reduce glare and create shade. Kemperman & Timmermans (2014) found that besides trees, the availability of grass also influences social interaction, since grass and trees provide places where people can meet. They also observed that with higher quantity of trees and grass present, higher levels of social contacts for elderly were found. Furthermore, researches on park attributes also showed the importance of (colourful) flowers for social interaction (Wang & Rodiek, 2019; Zhai & Baran, 2017). The flowers can be placed behind seating locations to give a secure feeling or by creating a beautiful scenery for people to watch (Swart et al., 2009).

2.5 URBAN DESIGN SOLUTIONS SOCIAL EMOTIONAL NEEDS

Social emotional needs of elderly can be complied with in public space design using a restorative space design. The concept of restoration within the built environment is getting more and more attention in literature as it has shown to result in higher levels of mental wellbeing and reducing stress. The sections below will explain what restoration is and how it can be used in public space design to meet the emotional needs of elderly in public spaces.

2.5.1 Definition of restoration
According to Kaplan and Kaplan (1989), who have played a massive role in the definition and understanding of restoration, restorative environments can help reduce mental fatigue. In order to understand how restorative environments can do this, one must first understand what mental fatigue is and how it occurs. Mental fatigue is a consequence of exposure to stressful or busy situations, that result in the reduction of ones' functioning (Kaplan & Kaplan, 1989). Living in an environment, especially urban environments, people use many resources on a daily basis, including physical, psychological and social resources. This can have negative effects on the mental well-being as one constantly pays the costs of adapting to those demanding circumstances (Collado et al., 2017). These impacts result in reduced functioning. However, being in such worn-out state does not mean that one cannot function at all (Kaplan & Kaplan, 1989). According to Kaplan and Kaplan (1989), this can be explained by the fact that there are two types of attention, namely indirect attention, and direct attention (based on the theory of William James (1892)). Indirect attention requires no effort, because the person is excited or interested. With direct attention, on the other hand, someone forces themselves to pay attention to something that they might not be interested in.

Other stimuli in the environment are direct competition of this attention (Kaplan & Kaplan, 1989). Kaplan and Kaplan therefore hypothesize that: *"when one experiences mental fatigue the underlying cause is fatigue of directed attention"*
- (Kaplan & Kaplan, 1989).

Mental fatigue can however be reduced by means of a restorative environment, which is an environment that is minimalized in the amount of directed attention it demands (Kaplan & Kaplan, 1989). In their 'Attention Restoration Theory' (ART), Kaplan and Kaplan (1989) explain how such restorative environment can be achieved, based on 4 key components;

1. Being away: People seek to 'escape' from current aspects of life that are not preferred. They either want to get away from distraction, they want to put aside work, or they want to take a rest from certain purposes. (e.g. going to the mountains, or watching tv)
2. Extent: People seek the sense of being in 'a whole other world' (e.g. playing computer game or repairing a car)
3. Fascination: People seek for a stimuli that is fascinating, which attracts indirect attention (e.g. wild animals or campfire flames)
4. Compatibility: People seek for an environment that offers possibilities to execute ones' purpose within the environment. (E.g. a quiet library to read a difficult text, or no obstacles on the road to find a certain exit).

Another important framework within restorative environments is the Stress Reduction Theory, created by Roger Ulrich. This theory is in line with what Kaplan & Kaplan state, as it relies on restorative environments that can reduce stress. Ulrich accidently found out that restorative influences of nature positively impact the emotional state of patients, and reduces stress (Ulrich et al., 1991).

2.5.2 Nature benefits on restoration

When looking at urban public spaces specifically, any public space could potentially embody all four components of the ART. But when not all components are incorporated correctly, a restorative environment cannot be created. So the context itself matters as well. Natural environments have proven to be containing those components necessary to create a restorative experience (Ulrich et al., 1991; Kaplan S., 1995). Within the framework of ART, Kaplan and Kaplan explain how all four components of the ART can be found within nature.

The first component of 'Being away' can be explained by the fact that because of urbanisation and the growth of cities, nature is not an everyday content anymore. So, nature meets the requirement of 'being away' quite easily. As for 'extent', urban green spaces should offer enough possibilities to get lost in order to be restorative (Kaplan & Kaplan, 1989). A small area of nature in an urban setting can still provide extent if trails and paths are designed in a way that a small area seems much larger for example (Kaplan S. , 1995). Some research has explored how this can be done in urban settings, using so-called 'pocket parks'. Nordh et al., (2009) for example, looked at which urban space elements in pocket parks had the most effect on restoration, and found that grass, bushes and trees have highest restorative value. Furthermore, Perschardt & Stigdotter (2013) also found that even small urban green spaces can be helpful in mental restoration. The third component 'fascinating' in nature can be found in soft nature, such as clouds, sunsets, or motion of leaves. Even though nature itself is not very unique, these aspects of nature can still be considered fascinating by most people (Kaplan & Kaplan, 1989).

According to a study conducted by Lindal & Hartig (2015) in Iceland, fascination mediates the effects on restoration likelihood by the number and arrangement of trees, as well as the presence of flowers.

Restoration in this study tended to be higher for streets with higher frequency of trees and flowers present. Finally, nature is also highly 'compatible', because for most people functioning in nature seems to be less effort than in a more civilized setting (Kaplan & Kaplan, 1989).

Many researches have come to the same conclusion that nature is more restorative than urban settings. Beute & Kort (2014) showed for example that only showing natural scenes already resulted in higher restorative benefits. Furthermore, Neale et al., (2020) found that brain activity associated with attention is reduced in green environments (related to the stress reduction theory). It is however important to note that just because natural areas can have restorative elements, it does not mean that nature on itself is automatically a restorative environment. As Heerwagen (2009) explains, natural environments that include dying plants and trees for example are a signal of depletion, and are therefore avoided. However, they also explain that not the whole environment needs to be restorative in order to have some restorative value, as small areas of nature, such as flower pots, trees, or small gardens, can already bring delight (Heerwagen, 2009).

Now that the general restorative value of nature is established, the question arises whether this is also true for the elderly population. That is exactly what Berto (2007) researched upon and they have found out that elderly and young people follow the same trend across evaluated restorative score of environmental categories. Which is also in line with the findings of Neale et al., (2020). So the previous statements on the influences of restorative environments on the mental wellbeing can also be applied to the elderly population.

2.5.3 Entropy in restoration

Besides nature, there are also other environmental factors that can influence ones' restorative experience. Entropy is another contextual factor influencing restoration. Within the built environment, entropy can be described as the frequencies of certain design characteristics (Lindal P. J., 2013), and thus contains a broad range of architectural elements. A residential area is built up from series of blocks of buildings, bordered by streets. The visual aspects of such blocks might influence how one perceives the urban environment when walking through it. Entropy is zero when all elements of the environment are identical, and maximum entropy can be reached when all those elements of the environment are unique (Lindal P. J., 2013). Lindal & Hartig (2013) stated that the more architectural variation in an environment will lead to more opportunities for engagement, and thus more indirect attention. So variation in shape, size, and surface attributes might influence restoration (Lindal & Hartig, 2013).

Some research has been done on the influence of entropy on restoration, such as Lindal & Hartig (2013), they found that higher buildings have a negative effect on restoration. Furthermore, Stamps (2004) did a lot of research on entropy within the built environment and found that visual diversity of the built environment and entropy are strongly correlated. When Stamps tested the relation between preference and entropy, some negative relationships were found, including facades of old buildings, presence of signs, and the residential contextual fit. Other design elements were found to have a positive correlation between preference and entropy, including commercial block facades, housing colours, scale, shape and articulation (Stamps, 2004).

Several other researchers have found similar results for the walkability when focusing on the building envelope. In the research of Singh (2016) for example, there is no specific focus on restoration, but the author states that urban morphology like block length and edge conditions do have an influence on how walkable the neighbourhood is. This has to do with the perceived safety that people get when a certain street feels enclosed. When a street is too closed off (here: narrow street, high buildings, few openings), the feelings of safety decreased massively, as people feel uncomfortable and almost claustrophobic (Singh, 2016). They also found a relation between the block length and the perceived walking distance: there is a higher walkability for shorter block lengths as people perceive this route to be shorter as well (Singh, 2016).

It is established that entropy influences restoration, however, not much is known about the actual restorative value of specific architectural elements. For nature, this is much more investigated.

2.5.4 Restoration and social interaction

Roe & McCay (2021) state that social contacts in the neighbourhood also have a positive influence on restorative experiences. Cattell et al., (2008) furthermore state that restorative benefits can be derived from certain spaces, but for most people, the social value was instrumental in reducing stress and maintaining health and wellbeing. Collado et al., (2017) also found that the social aspects in relation to restoration extend beyond immediate social context. So, to some extent social interactive and social emotional needs are correlated to each other. However, there is not been enough research on this topic to make a definitive conclusion. Especially considering the restorative value of other aspects of public space as well. Abdulkarim & Nasar (2014) for example found that plaza seating improved restorativeness, where they hypothesized that the more visitable a public space is, the higher restorative value it has.

The issue is that researching the restorative value of public space can be quite difficult as restoration is difficult to measure. Generally, there are two ways to measure restoration of an environment. The first method is to measure physiological reactivity, such as heart rate, pulse, neural activity, etc. that give indications of levels of stress and brain activity (Beute & Kort, 2014; Neale et al., 2020). This can be linked to the stress reduction theory. The second method is the perceived restorativeness scale (PRS), developed by Hartig et al. (1997), shown in figure 14 and is based on the four components of the attention restoration theory.

Figure 14_ Perceived Restorativeness Scale

Being Away
It is an escape experience.
Spending time here gives me a good break from my day-to-day routine.
Fascination
The setting has fascinating qualities.
My attention is drawn to many interesting things.
I would like to get to know this place better.
I want to explore the area. (In Study 2 this item was replaced by the item below.)
There is much to explore and discover here.
I would like to spend more time looking at the surroundings.
Coherence (Extent)
There is too much going on.
It is a confusing place.
There is a great deal of distraction.
It is chaotic here.
Compatibility
I can do things I like here.
I have a sense that I belong here.
I have a sense of oneness with this setting.
Being here suits my personality.
I could find ways to enjoy myself in a place like this.

Source: Hartig et al. (1997)

This latter is a commonly used method to measure restorativeness of an area, for example by Perschardt & Stigsdotter (2013) and Nordh et al., 2009), since it offers an insight on which aspects of the ART it is restorative and thus a more specified conclusion can be made. However, this is also a more subjective method, which can make it more difficult to link certain attributes to restoration such as social interaction. In this report, entropy and green are therefore categorized as attributes with restorative value, but further research is needed to find the restorative value of other public space elements.

2.6 OVERVIEW NEEDS OF ELDERLY

Table 1 and 2, shown below, provide an overview of the physical and social needs that elderly have according to the literature. In table 1 the physical needs are presented divided on a scale from physical accessible to physical comfortable needs. Those attributes placed towards the physical accessible side of the table are mentioned very frequently in the literature, and were shown to be important for elderly to make public spaces accessible. When these attributes are not accounted for, it may be possible that elderly will avoid these public spaces. Those attributes placed more towards the physical comfortable side of the table are mentioned less frequently by literature. It should be noted though that this table is not an indication of which attributes are necessarily more important for elderly, as preferences are personal. But the table does give an indication of which attributes are necessary to create an all-inclusive public space design (physical accessible) and those attributes that can contribute to higher levels of satisfaction (physical comfortable).

Table 2 shows the social needs of elderly ranging from social interactive to social emotional. The attributes towards the social interactive side can create places that stimulate social interaction as previously explained. The attributes on the social emotional side are related to the restorative value of the environment. Similarly to table 1, the table does not provide the order of importance, but is merely an indication of the attributes playing a role in certain social purposes.

Table 1_ List of physical needs elderly from accessible to comfortable

Physical accessible

Attribute	Preference elderly	Source
Pavement type		
Quality	No cracks, holes, or deformations.	(Ferreira & Sanches, 2007) (Moura, Cambra, & Conçalves, 2017)
Type	No slippery or uneven floors. Smooth regular pavement from firm materials. Grass should be avoided	(White, Toohey, & Asquith, 2015) (Australian Human RIghts Commissions, 2008) (Zhai & Baran, 2017) (Ferreira & Sanches, 2007)
Width	Free of obstructions, effective width 1,5m to 2m	(Bollard & Fleming, 2013) (Ferreira & Sanches, 2007) (Turel, Yigit, & Altug, 2007)
Seating placement	Adequate amount of seating needed roughly every 200 m	(Ståhl , Carlsson, & Hovbrandt, 2008)
Height differences	Pavement height max 15 cm. preferred ramp between 6cm and 12 cm	(Boenke & Schreck, 2014) (Turel, Yigit, & Altug, 2007)
Street crossing	Traffic calming measures at crossings	(Bollard & Fleming, 2013) (Michael, Green, & Farquhar, 2006)
Separation transport modes	Clear definition of pedestrian zone, separated from bicycle lane and motorized vehicles	(Cauwenberg, et al., 2014) (Ståhl , Carlsson, & Hovbrandt, 2008)
Seating quality	Wooden bench with arm- and backrest	(Mumcu & Yilmaz, 2016) (Gehl, 2011)
Visibility	Vegetation should not hinder vision lines	(Wang & Rodiek, 2019)
Atmosphere	Seating and walking should be sheltered from wind, rain and drafts	(Swart et al., 2009) (Whyte, 1980)
Pavement cleanliness	No littering/ no violence/ no graffiti	(Swart et al., 2009)

Physical comfortable

Table 2_ List of social needs elderly from interactive to emotional

Social interactive

Attribute	Preference elderly	Source
Seating composition	Seek for interaction with other users, talkscape is preferred or semicircular bench	(Swart et al., 2009) (Gehl, 2010)
Atmosphere Lighting	Light should illuminate peoples face for social interaction	(Kunduraci, 2017) (Gehl, 2011)
Sound	Background noise should not exceed 60 dB	(Gehl, 2011)
Pavement width	Functions require space, more interaction can take place with wider path	(Rad & Ngah, 2013) (Aelbrecht, 2016)
Seating location	Edge effect: along the edge with an interesting view	(Gehl, 2011) (Aspinall, et al., 2010) (Francis, 1987)
Green locations	High levels of grass and trees for social interaction	(Kemperman & Timmermans, 2014)
	(colourful) flowers for social interaction	(Swart et al., 2009) (Wang & Rodiek, 2017) (Zhai & Baran, 2017)
Entropy restorative	Variation in shape, size, façade, colour, and scale might influence restoration	(Lindal & Hartig, 2013) (Stamps, 2004)
Green restorative	Grass, bushes, trees have highest restorative value	Nordh etal., (2009)
	Small urban green areas can still have restorative value when they are 'extent', 'fascinating', and 'compatible'	(Kaplan S. , 1995) Nordh etal., (2009) (Kaplan & Kaplan, 1989)

social emotional

2.7 PROFESSIONAL INPUT ON NEEDS ELDERLY

From the literature review, many aspects of the public space have shown to be of importance for elderly. In this research not all aspects can be researched upon, so several professionals were consulted to find out which attributes are most important for elderly. Appendix A shows the informal interviews that were held with: location coordinators of health organizations, as well as a project developer for that health organization. Furthermore, a doctor specialized in elderly care and two supermarket managers were consulted.

As discussed in the literature review, the physical restrictions of elderly are very important according to all professionals. Mostly accessibility of the public space is a determinant for elderly whether they like to be somewhere or not. From the informal interviews became clear how important age-inclusive design is, based on the elderly needs related to speed, responsiveness, and height differences.For elderly specifically it is important to consider obstacles in public space and how they are placed.

Seating should be placed for elderly to be able to rest, but they should not be an obstacle on the pathways. More space will therefore result in more comfort for elderly. Besides the seating, there should even be more space available for people in a wheelchair or to store other walking aids, such as rollators. Green should also not be an obstacle, even if it has a positive effect on the mental wellbeing. Furthermore, when people have conversations in one place, there should be enough place for other people to pass.

Even though the accessibility should be optimized, in the interviews it was also mentioned that in reality elderly will not always choose the most accessible option. Elderly tend to take the shortest route, even if that is a more uncomfortable pathway, such as cobblestones, a route with tree routes, or snow. This can create dangerous situations. Other design solutions that should improve accessibility can also have negative effects. Slopes can for example be an alternative for height differences, but it depends on each situation if it will work, depending on frequency, time, and effort it takes.

From the interviews also became clear that elderly value recognizability of a space. From literature, this subject was less prominent, but during the interviews became clear how much this might influence the route choice for elderly. It should be noted though that most of these comments were made by those professionals who worked with elderly that have low levels of independence. But for those people, a space should be inviting, clear, and recognizable. Feelings of safety was another important aspect for elderly. Criminality and vandalism play an important role in those feelings of safety, but also risk of falling. Visibility could positively influence the feelings of safety, and feeling at ease somewhere. This also plays a role in seating, where the walking route should be in sight, which is in line with the ‘edge effect’ from the literature.

Finally, social interactions are important. In contrary to the statement that elderly do not like to visit crowded areas, one of their favourite activities is watching other people. This is also mentioned in literature, however it should be noted that elderly like to watch busy areas, but do not want to be in that busy area themselves. For seating areas, the place should be inviting, and people can choose themselves if they want to interact with others or not. In both cases, view is very important.

2.8 CONCLUSIONS LITERATURE REVIEW

From the literature review can be concluded that some aspects of public space design are very important to make a space accessible for elderly, even though it might not be important for other age groups. This is mostly related to the reduction of the physical capacity that comes with the ageing process. But the literature also showed the importance of mental wellbeing for the elderly age group, and the importance of designing public space in such a way that they are restorative. The informal interviews confirm the importance of most of the attributes, such as accessibility of pathways without obstructions, the quantity and quality of resting places, and the importance of social interactions for the mental wellbeing. The interviews did show however that visibility and clear and structured routes tend to be more important than what was found in the literature initially.

One thing to be noted is that most research focusses on either the physical limitations and all-inclusive space design, or it has its main focus on social aspects and how public space design can improve mental wellbeing. A research gap can however be found in the preferences that elderly have when looking at both physical and social needs.

3. Experimental design

In this chapter will be explained how the experiment is built up and how it will be executed, including the explanation of the attributes that will be research upon. Hypotheses will be created for the preferences of elderly on these attributes. Finally, the last section will focus on how the data can be used to determine the preferences of elderly, using specific equations.

3.1 STATED CHOICE EXPERIMENT

To answer the research question, a stated choice experiment will be used to find the preferences and trade-offs between physical and social needs of elderly during their daily walk. This research is connected to a study that created a framework to evaluate and score public spaces on elderly-friendliness (Ossokina and Jurgenhake, 2021) . In that study, existing daily walking routes are evaluated to see what can be improved. With the results of the current research, these evaluations can be quantified.

The public space that is researched upon here will be the route towards the supermarket. The reason for this decision is that elderly generally perceive grocery shopping as a daily necessary activity as well as social activity, executed more frequent than most other activities. Statistics in the Netherlands show that as opposed to the low frequency leisure walks of elderly, this age group does visit grocery stores 4 to 5 times a week on average (CBS, 2020) and Ariza-Álvarez et al., (2019) showed that the frequency of grocery shopping is much higher for the age group of elderly in general. So, to be able to improve active ageing for elderly, and increase their frequency of walking, first it is important to better understand the combination of both physical and social needs of this age group on the route towards the supermarket.

To find the preferences of elderly, a stated decompositional choice experiment will be used, giving the respondents a set of alternatives to choose from each time (Louviere et al., 2000). The results can then reveal how much elderly value a certain attribute level over another. A stated choice experiment has the disadvantage that it does not represent a real situation, and thus cannot predict if participants would make the same choices in real life. In order to reduce this disadvantage, the choice sets will be visualised, representing the real life situations as much as possible, which will be explained in chapter 4.

There are 5 attributes in this experiment, from which 4 of them have two attribute levels, and the last one has 3 attribute levels. This means that there are 48 different possible alternatives in total. In order to reduce this amount, a fractional factorial design will be used, and only 27 alternatives remain. Section 3.2 will explain all attributes, and appendix B shows a full overview of the fractional factorial design including all attributes.

Within the stated choice experiment each participant will be presented with 5 choice sets of two alternatives. They can choose either one of the alternatives, or choose a third option that is neither of the alternatives. After the choice set, the respondents will also be asked to indicate how long they are willing to walk along that specific routes for each of the alternatives in general (so not towards the supermarket). This can later be used to determine the willingness to walk in minutes in general.

An online survey is chosen to collect the data. Lime Survey is used to create the survey , which does not allow for a completely randomized process of allocating 5 different choice sets to each participants. Therefore, 40 question groups are created with each 5 choice sets. The choices within these question groups are completely random, but are never the same. Participants are then randomly allocated to one of those question groups. The survey will consists of two parts: information about the participants and the other part consists of the preferences of choices. Within the information about the participants, some socio-economic characteristics are asked, such as age, household composition, marital status, retirement, etc. But the personal information also contains some questions about the mental well-being and physical well-being of the participants. Because of this delicate information, all questions were reviewed by the Ethical Review Board of the Technical University Eindhoven and were approved. Furthermore, the questions of the choice sets were elaborated with additional question for each of the alternatives how long one was willing to walk along that route.

3.2 ATTRIBUTES

As previously shown, there has been much research on the limitations that come with the ageing process and how public space design can play a role in this. Do elderly prefer to have high social value of a public space, or are their physical limitations too high and is it more important to incorporate their physical needs first? Within the stated choice experiment of this research, both physical and social attributes are included to get better insight in these preferences. The sections below explain which attributes will be used in the experiment, based the physical and social needs of elderly found in the literature review and informal interviews with the professionals. An overview of the attributes is given in table 3.

In a stated choice experiment usually the Willingness to Pay (WTP) is used to determine the monetary value a person is willing to pay for a certain attribute to gain satisfaction. Since this experiment is about public space design, the WTP will be expressed in the effort it takes for people to execute the activity of walking to the supermarket. Because of physical limitations that elderly might have, it will generally take more effort and time for them to cover a longer distance. It is however rather difficult for a respondent to estimate how much effort something is when distance is measured in meters, therefore the length of the route will be measured in minutes. Bollard & Fleming (2013) found that elderly have lower walking speeds and in 5 minutes they can cover a distance of 250 meters on average. When looking at the average distance to the supermarket in Dutch cities, this is about 700 meters (CBS, 2021c) and thus would take elderly a little under 15 minutes. However, there is no data available for the distance in high urbanized areas, which is the scope of this research, but this will be less than 700 meters. Furthermore, Alvarez et al., (2019) have found that in residential areas, elderly were not willing to walk more than 15 minutes to reach grocery store locations. The attribute levels in this research will therefore be 5 minutes and 15 minutes. The intermediate attribute level of 10 minutes is not included, as the difference between 5 and 10 minutes and between 10 and 15 minutes is not large enough to 'feel' the difference in effort and people might be indifferent about it. Whereas a difference between 5 and 15 minutes does provide this feeling of more effort.

Since a stated choice experiment is performed, not all attributes from literature can be used in the design of the experiment. For physical, we will therefore look at the physical accessible part of table 1 that includes pavement type, pavement width, and seating placement. For all three attributes, there will be 2 attribute levels, for which one is the level that resembles most real-life situations. The other level will be the preferred level of elderly when looking at the literature. For pavement type this means that one level is regular tiles with unevenness (and/or small cracks) that can be seen on most pedestrian pathways in the Netherlands. The other level is a smooth regular pavement, like asphalt, as this is preferred by elderly according to literature (Moura et al., 2017; White et al., 2015; Australian Human Rights Commissions, 2008; Zhai & Baran, 2017; Turel et al., 2007). For the attribute of pavement width, the attributes levels will be called 'small' and 'wide', in which small is based on most real pedestrian one-way sidewalks in the Netherlands of approximately 90 cm, and wide is based on literature preference of elderly of 1.5m to 2.0m wide (Bollard & Fleming, 2013; Ferreira & Sanches, 2007; Turel et al., 2007). The last physical attribute of seating placement will have the attribute levels of no bench on the route, or a bench on the route, again based on the preference of elderly in literature (Ståhl et al., 2008).

These attributes will be compared to a social emotional attribute that is the restorative value of scenery. This attribute will have three levels consisting of a route through the neighbourhood without green, a route through the neighbourhood with green added, and a route through green, such as a park. These levels are based on the literature on restorative value, explained in chapter 2.4.

In a stated choice experiment, more attributes could be used, however visualizations will be used to show differences between alternatives and too much information might be too overwhelming for respondents, more details of this topic will be discussed in chapter 4. The overview of all attributes and their levels used in this research is shown in table 3.

Table 3_ Attribute and attribute levels in experiment

Attribute	Level 0	Level 1	Level 2
Length of route	5 minutes	15 minutes	-
Pavement type	Tiles	Asphalt	-
Pavement width	Small	Wide	-
Bench on route	No bench	Bench on route	-
Scenery	Route through neighbourhood without green	Route through neighbourhood wih green	Route through green

3.3 HYPOTHESES

For each separate attribute, it is already clear which level elderly prefer, since it is based on their preferences from the literature. Nonetheless, it is interesting to investigate the relation between the different attributes. To answer the (main) question of this study, several hypothesis were formed based on the literature review and input from professionals.

H1: In general, elderly will prefer a green (restorative) scenery over physical attributes. Within the physical attributes, pavement type is expected to be most important, followed by pavement width, and finally bench on route.

The green scenery is expected to have the highest positive value, as according to literature restoration has a big impact on the mental wellbeing. Not every elderly person has mobility issues, and is in need of a certain physical attribute, however most elderly are likely to be in need of a restorative environment, just like any other age group. The route through the neighbourhood without any green is therefore expected to have a negative value, as it is expected that elderly rather take a detour through a green environment than having no green at all.

It is expected that the most important physical attribute is pavement type. This attribute is mentioned in most of the literature to be a major obstacle for most elderly. Even with minor physical restrictions, uneven or irregular pavement can cause issues, or can just be an annoyance. Pavement width and a bench on the route are expected to have comparable positive values. A bench is expected to be very important for people with a mobility restriction that are not able to walk long distances, however, it is expected that this group of elderly is relatively small. In addition, people in a wheelchair do not need benches at all. Therefore, pavement width is expected to have slightly higher value than the presence of a bench on the route. The importance of pavement width however is an attribute that is difficult to predict. First of all, people with a walking aid need extra space on the pavement to move around freely. Furthermore, elderly have slower walking speeds and might feel more comfortable on a wider pathway where other people can pass them more easily. Third, elderly might be in need of more space because they want to walk with someone else (table 2 shows that pathway width could also be a social attribute) or elderly might not be able to walk entirely independent, and might need some care taker with them, which also takes extra space. Finally, in general, the width of the pathway might also influence ones perception of the public space itself, as with more space people generally feel more comfortable. All in all, there are more reasons for elderly to be needing or preferring a wide pathway, which makes it difficult to predict. The specific reason that people will make a choice is not asked, but since all these option might influence their choice, pathway width is expected to be more important than a bench.

Since it is expected that the group of elderly is not homogenous, the following three hypotheses were created about the preferences for more specific target groups within the elderly population:

H2: The oldest group of elderly (age 75+) are expected to value physical attributes over the social attributes, as elderly get more mobility restrictions when growing older. But since they also generally have more time, restoration is still important. So the order of importance for the age group of 75+ is expected to be : pavement type – (green) scenery- bench on route – pavement width

H3: Elderly that have some type of mobility restriction are expected to value physical attributes over social attributes. The order of importance for this group is expected to be: Pavement type- bench on route- pavement width- (green) scenery.

H4: Elderly that have some kind of reduced mental wellbeing are expected to value the social attribute of green scenery over the physical attribute. The order of importance for this group is expected to be: (green) scenery – bench on route- pavement type – pavement width

3.4 DATA PROCESSING

After data collection, the data of the choice sets is coded with dummy coding. The program R Studio is then used to estimate the model. First a Multinomial Logit Model (MNL) is executed to estimate the utility and probability of profiles. A Latent Class Model is then executed to find heterogeneity within the group of elderly. The relative importance of the attribute levels can then be determined. Here we use a conventional multinomial logit model. In further research, more complex discrete choice models may be tested as well, such as: nested logit (e.g. Ossokina et al., 2021), mixed logit (e.g. Tiellemans et al., 2022).

Utility can be calculated using equation 1 and 2. The utility *(U)* of a person *(q)* of alternative *(i)* is dependent on *V. V* is determined by the sum of the score *(X)* multiplied by its weight *(β)* of attribute *(n)*. The utility determines the level of satisfaction of a person.

(1) $U_{iq} = V_{iq} + \varepsilon_{iq}$

(2) $V_i = \sum_n \beta_n X_{in}$

The probability can then be calculated using equation 3. It shows the probability of a person *(q)* choosing one alternative *(i)* over another. For each alternative can then be calculated what the probability is for a person.

(3) $P_i = \frac{\exp\,(Viq)}{\sum i' \exp\,(Vi'q)}$

The willingness to pay (WTP) of the model can be determined using equation 4. This will reveal how many minutes elderly are willing to walk to gain a certain attribute. It could therefore also be called ‘Willingness to Walk” however, in the rest of the report WTP will be used. The β_O refers to the weight of the preference attribute that is measured in minutes.

(4) $WTP = -\frac{\beta_n}{\beta_0} * 10$

Finally, participants were also asked in a follow-up question to indicate how long they were willing to walk along each of the routes shown in the alternatives in general. an Ordinary Least Squares (OLS) can be used to determine the willingness to walk in general (so not towards the supermarket). It will also show for each of the attributes how many minutes extra elderly are willing to walk, using the following equation:

(5) $Y_i = \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_p x_{ip} + \varepsilon_i$

4. Visualizations

In this chapter will be explained how the visualizations in the choice sets are created. First, the type of visualization is established based on literature. Then, the degree of realism is determined based on both literature and input from the target group. The input from the target group is obtained through some informal interviews with 12 elderly people. Finally, step by step will be explained how the images are build up and how all attributes are incorporated within the visualization.

4.1 COMPONENTS OF VISUALIZATION

In stated choice experiments, it is important that the respondent understands the difference between the choice sets presented to them. Hurtubia et al., (2015) explain that context is usually achieved by retrieving a memory of the respondent in the alternatives, so that people can base their choice on existing situations. However, this might be difficult when someone should judge a hypothetical scenario, especially for public spaces.

As explained before, in this research, respondents will be asked to make a choice between two alternatives that are combined of urban design elements in an online environment. When providing respondents these contexts with text-only choices, the chances of misinterpretation are likely to increase. Hurtubia et al. (2015) validate this by stating that text-only will require that respondents read, interpret, and visualise such scenario by themselves, which can lead to bias. Based on these reasons, it was decided to use visualizations in this stated choice experiment to reduce misinterpretation.

There are a lot of aspects that should be taken into account when creating the visualizations in this research. First of all, the type of visualization can be 2D, 3D, or VR. The level of realism should then be determined, ranging from sketch to photo-realism. During this stage, the perspective of the visualization is also taken into account which would best represent the attributes and their levels. Finally, the images can be created, but decisions should be made for things like level of details, contrast, filters, textures, scales, etc.

4.2 TYPE OF VISUALIZATION

The options for visualization considered in this research consist of 2D, 3D static picture, 3D dynamic film sequence, and Virtual Reality. Eventually 3D static pictures were chosen by elimination of the other options. See Zhao et al. (2022a, 2022b) for examples of visualizations involving video and virtual reality modes.

4.2.1 3D film sequence and virtual reality

Mokas et al., (2021) found that the certainty of respondents in stated choice experiments increases by using more immersive types of visualization. This is related to the respondents being able to experience the street close to a real life situation. However, there are some disadvantages. Rid et al., (2018) did thorough research on the use of film sequences in stated choice experiments and had several remarks. First of all, even though the realism is much higher than for static 3D images, there could be too much information and detail in the film sequence, which might be overwhelming for the respondents. Furthermore, the movements of the film sequence might have been a distraction for the respondents from seeing the differences in attributes. Therefore, respondents might not always be able to absorb all information provided (Rid et al., 2018). Another finding in their research, is that some of the respondents in their study did not take time to view the whole film sequence after seeing two or three of the choices, and they just based their choice on the initial image of the film sequence (Rid et al., 2018). This reduces the amount of perceived information massively, and might lead to invalid results. They finally concluded that the 3D film sequence was actually outperformed by 3D still-images (Rid et al., 2018).

Virtual Reality has quite similar advantages and disadvantages as 3D film sequence. Farooq et al., (2018) have found that preferences of respondents in stated choice experiments became more consistent when using virtual reality over text-only or visual animation. However, Patterson et al., (2017) came to a different conclusion. Even though they did find that virtual reality models seem to be marginally better than text-only models, they are not strongly superior to them. They even conclude that visual attributes did not have greater importance than text attributes. Combining this information with the difficulties that come with virtual reality, such as large file sizes, but also executive difficulties due to COVID-19, Virtual Reality and 3D film sequence are not chosen for this research study.

4.2.2 2D and 3D static images

2D or 3D still images remain as options to include visualization in this stated choice experiment. According to Herbert & Chen (2015) there is no real consensus on how effective 3D visualizations really are. When comparing the two options, they found that 2D visualization seem to show more variability in simple tasks, such as height or length, and 3D seems to score higher for complex tasks such as shadows. In order to decide which visualization works best in this specific experiment for elderly, some elderly were asked about their opinion on several types of 2D and 3D visualizations, explained more thoroughly in the next section. The 2D option was the least preferred option in this specific experiment, since not all attributes could be shown clearly in one 2D image. According to those elderly, the 3D images showed the attributes best, therefore 3D still images are chosen in this experiment, in combination with textual information as well. Text will be added because, according to Shr et al., (2019) visualizations and text combined will inhibit stronger preferences by the respondents than just text or images by themselves. They also state that respondents are less likely to ignore certain attributes when presented in text and images combined (Shr et al., 2019). Mokas et al., (2021) found similar results, where adding pictures in a choice set lead to lower error variance, because different people might engage better with text and others with pictures. Patterson et al., (2017) further stimulate these statements by saying that visual attributes are not perceived as more important than text, and the combination allows respondents to focus as much on the text as on the visual attributes.

So, from literature and several opinions of the target group can be concluded that visualization of 3D static images in combination with text are preferred for this experiment. The next step is to determine the degree of realism of the images.

4.3 DEGREE OF REALISM

Generally speaking the degree of realism in a 3D static image can range from a rough sketch to a photorealistic image. A sketched image is more open to interpretation (Hannibal et al., 2005), as opposed to photo-realistic, which can be perceived as a fixed solution (Billiger et al., 2016). The same can be said about the use of colours. When colours are used, the scenario will seem more realistic, but also gives the impression of a fixed solution (Hannibal et al., 2005).

This can be a problem in this stated choice experiment where it is just about the preference of the attributes in general, and not about the specific design of the public space. When deciding which degree of realism the images should have, the target group is very important, as different groups might add different values to certain images when interpreting. Hannibal et al., (2005) concluded for example that architects have a different view on images than non-architects. Furthermore, they also found differences between architectural students who just started the course that preferred photorealistic images, and architectural students at the end of the course who valued mechanically drawn images more (Hannibal, Brown, & Knight, 2005). These type of researches show the importance of knowing for which target group the images are created.

Therefore the target group of elderly have reviewed the degree of realism for the visualization of this experiment. Several (2D and) 3D images were shown, with differences in degree of realism, perspective and colour. All images shown consisted of an eye-level view as this allows for the respondent to imagine themselves being in the scenario. Dongen & Timmermans (2019) have also chosen this perspective in their research of walkability as, according to them, the eye-level gives the best view of the low speed activity of walking where there is much interaction with its direct surroundings.

route towards the supermarket to see which type of visualization would be perceived best by the elderly target group. Each of the images included the same attribute levels , so that the only difference would be the type of visualization or the degree of realism. For the route towards the supermarket, 3 types of visualizations were created. The first one, shown in figure 15, consisted of a 3D vertical sketch in black and white. This has low level of realism, and thus allows for more interpretation.

Figure 15_ 3D static sketch

The second option for the route towards the supermarket is shown in figure 16 and is a 2D (horizontal) sketch in black and white, consisting of 2 images in 1. This has low level of realism and thus allows for much interpretation as well. The difference between the first option and this option is 2D versus 3D, as well as the need of an extra image to show all attributes (width of the pathway).

The last option for the route towards the supermarket is a 3D photo-realistic image in colour, shown in figure 17. This is on the high end of the scale of realism. In this stage of the creation of visualization, the photo-realistic images did include some computer-generated sketch or near-photo-realistic features as well, such as the bench and the person walking on the pathway. This was chosen to show people that it was not a real situation, which hopefully lead to respondents thinking about this as a hypothetical scenario that could look different.

Figure 16_ 2D (horizontal) sketch

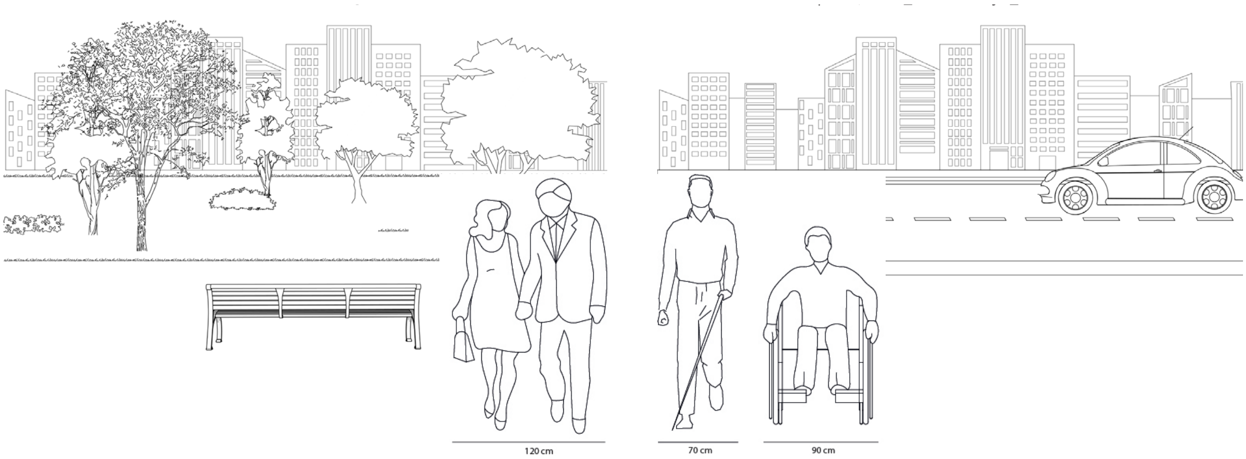


Figure 17_ 3D near photo-realistic

In total, 12 elderly people were asked about which of the visualizations were most clear and which they would prefer in the experiment . The reactions are shown in appendix C. The second option was only chosen by two people, and most of the others had this as the least preferred option for the following reasons: The width of the pathway needs a separate image, which can be distracting. The elderly that were interviewed mostly preferred all attributes to be in one image, to have a clear overview. Having the perspective vertically (option 1 and 3) also allows elderly to get a better feel of how the attributes look like combined. This means that the perspective is more logical vertically, looking into the street, so 3D instead of 2D.

Between the first and the third option, there was a tie. The most frequently mentioned reason for option 3 was that by the addition of colour and realism it was easier to imagine what the attributes would look like in real life and a decision could then be made quicker. Reasoning for people not to choose the photo-realistic option were the small details like the dark colours or shapes were distracting. Another reason to choose the sketch over photo-realistic option is because people need just enough detail to understand the situation, so a clear picture that is not too crowded. Finally, the addition of the sketched person in the third option did not reach its initial goal of letting people think it is about a hypothetical scenario and brought more confusion than clarification.

mages in colour were chosen. According to both the literature and the conversations with the target group this has advantages and disadvantages. First of all, the advantages include: with higher level of realism, elderly people find it easier to place themselves in the situation and better understand what is happening. Since these images are created using actual pictures of real life situations, elderly might therefore also recognize them quicker.

Another advantage that is not mentioned before is that the stated choice experiment requires many versions of images with each different combinations of attribute levels. Using Photoshop and adding the attribute levels as layers is more practical as it is time-saving and allows for much quicker and easier adaptations of the images. The continuous process of optimizing and improving the images is therefore much more convenient. As explained before, one of the disadvantages of a photo-realistic images is that it might be perceived as a fixed design solution. It is therefore very important to optimize the design as much as possible to reduce the disadvantage.

4.4 LEVEL OF DETAIL

Photoshop is used to create the different images. Attributes are added as layers, so several alternatives can easily be made and adapted. Two basic scenarios were used, a park and a neighbourhood. Feedback from the target group on the neighbourhood included that the picture was too dark/clouded/sad. Since the basic scenarios are pictures of a real life situation, therefore a more neutral image was used, shown in figure 18.

Figure 18_ Base scenarios visualizations (left: park; right: neighbourhood)

Sources: Pictures taken by author

To make the comparison between alternatives as easy as possible, the background of both scenarios are the same. This includes the sky and the perspective of the image, in which the pathway is placed the exact same. For each of the attributes is explained below how they are integrated into the basic scenarios.

4.4.1 Scenery

The most prominently shown attribute in the image is the scenery, in which people have the option to walk through the neighbourhood or to walk through the park, with a third option to walk in a neighbourhood with some green.

The basic scenario for the park is a pathway with grass on both sides. According to (Nordh et al., 2009) grass and trees have very high restorative value and are therefore chosen to be used in the experiment. The base scenario already contains grass, and only trees needed to be added. According to Wang & Rodiek (2019), canopy trees are preferred by elderly, and multiple studies have found that a higher quantity of trees in general is also preferred (Kemperman & Timmermans, 2014; Alves et al., 2008). However, when comparing reality to a photo, the quantity, density and type of green can be perceived differently. Figure 19 for example shows a photo of a real situation with green that is very calming and relaxed in real life, but in the picture it looks crowded, overwhelming, and to some even ugly. Similarly, flower beds and colourful flowers or bushes can have the same effect in a picture.

Figure 19_ Image of calming green in real life

Sources: Pictures taken by author

Furthermore, type of green is a very personal preference. Someone might not choose the green option based on the colour, shape or density for example, even though that is not the goal of this experiment. So, the amount of green, the type of green, the height differences, the density, the colours, etc. should all be taken into account and should be as neutral as possible. The final image of green (figure 20) shows the grass with some trees. This is enough green to understand the use of the attribute, without there being too much green or without it being a fixed solution. The third attribute level is an in-between level where the neighbourhood is the base scenario, and the exact same trees as in the green scenario are added to the neighbourhood.

Figure 20_ Green scenery (left); neighbourhood with green (right)

4.4.2 Width of pathway

The attribute levels for pathway width are small (<0,90m) and wide (>1.5m). But a number for width does not say much to most people. Especially when using an image, the width should be clear and people should be able to imagine from the image how this translates to a real life situation. Therefore, a person is added to the pathway to show how much room there is. Initially this was a person in a wheelchair, however feedback showed that people that are not in a wheelchair themselves might not relate to this. Therefore, 2 elderly people walking next to each other are used to provide a feeling of what fits and what does not fit on the pathway. These people are wearing neutral clothing, and are placed in the exact same position for each of the alternatives so that comparison can be made more easily. Finally, a scale of width is also added to put a bit more emphasis on this attribute.

4.4.3 Type of pavement

For pavement type, the attribute levels include tiles and asphalt, making a difference between an uneven pathway with cracks and a smooth even pathway. Initially cobble stones were used for the tiles as they show the difference better (figure 21.1), but this is not a realistic situation and was therefore changed to regular tiles (figure 21.2). Since the regular tiles still looked 'too clean', extra contrast was added to show the irregularities and unevenness better (figure 21.3). In the end, this attribute does rely a bit more on the imagination and memory of respondents, as well as the text.

Figure 21_ (1) cobble stone; (2) regular tiles; (3) regular tiles with extra contrast

4.4.4 Benches along the way

The bench was placed in the same place for each scenario. At first, a sketched near-photo realistic image of a bench was used. However, this looked odd, at this point it was the only thing in the image that was not completely photo-realistic (figure 22.1). So, a picture in the correct perspective was photoshopped in the image (figure 22.2). Colours and contrast etc. was added to make it stand out more as it faded a bit into the background because of the grey/ brown colours (figure 22.3).

Figure 22_ (1) sketched bench; (2) real bench; (3) real bench with optimized colours

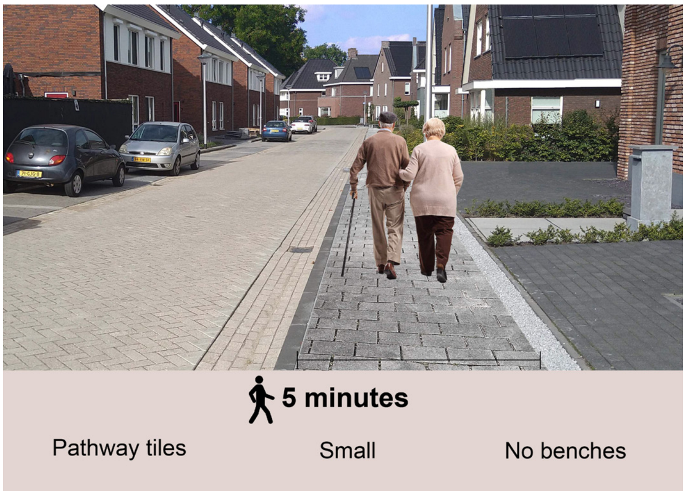
4.4.5 Length of the route

The final attribute is the length of the route, which is the only attribute that is not integrated into the image itself as an image. It is therefore added as text-only. This is the preference variable and needs to stand out as much as the other attributes. Several options were explored, but in the end an extra colour is added to the background. In the process, the text itself was also optimized as much as possible, to reduce the time it takes for a respondent to take in the images and the differences.

4.5 FINAL VISUALIZATIONS

Based on literature, conversations with the elderly target group, professionals, and others, the visualizations were optimized into what fits the research aim the best. Figure 23 shows how the questions were asked within the experiment (showing two opposites of attributes in a choice set).

Figure 23_ Final visualizations used in experiment



5. Operational design

In this chapter will be explained how the experiment is executed, how the data is collected and cleaned before it can be used for the analyses. The cleaned data is then investigated by grouping it into socio-economics, physical data, social data, and finally data on the use of supermarkets.

5.1 DATA COLLECTION

The data collection is done through an online national survey via PanelClix . People aged 65 and older, living in urbanized areas of the Netherlands (‘moderately urbanized’, ‘strongly urbanized’ and ‘extremely urbanized’ according to CBS (CBS, 2021d)) are sent an invitation with a link to the survey. Another requirement for participation in the experiment, besides age and postal code, is that they must have walked somewhere in the past two weeks, so that they have some active recollection of what is important for them while walking. After respondents have agreed to the consent form, the questionnaire is structured as follows: first there are some closed personal questions, like age group, gender and zip code. But also some closed questions about their physical condition related to walking to the supermarket. Furthermore, some questions were asked about their social and mental wellbeing on a 5-point Likert scale. This is followed by some additional closed questions about their use and frequency of their current supermarket. One of these questions includes the satisfaction of the current route towards the supermarket, followed by an open text box to explain their answer. Then, the choice game begins. As explained before, 5 choice sets will be presented to the respondent, including the additional follow-up questions to state how long the respondent is willing to walk along the specific routes shown in the choice set. After the stated choice questions, the questionnaire is ended with some socio-economic questions. An overview of all questions in the questionnaire is shown in appendix D.

The collection of the data was done in December 2021, and there are 415 respondents that completed the survey. In order to use the data, some data cleaning needed to be done.

In order to use the data, some changes were necessary. First of all, regarding the question whether people use a walking aid or not, an ‘other’ option was added as an open question. Some people used that open space to write one of the options mentioned above. These responses were changed manually to include them in the correct category. Furthermore, for household composition, there was the option to check multiple boxes for who are part of the household. All respondents that have checked the box of ‘myself’ in combination with other people in their households have been removed from ‘myself’ so it can be tested how many people fall into the ‘alone’ category. Finally, respondents were asked to fill out their postal code. This was translated to urbanization scale according to CBS, as described above.

In addition to the changes that were made to the data, 7 respondents were removed from the data sample, using the following criteria: (1) All respondents should have a postal code falling within the requirement of urbanized area (2 respondents are removed because of this), (2) All respondents within the lowest one percentile of the total time to fill out the questionnaire will be removed. The data analysis was done with the 408 remaining participants.

5.2 DATA ON PARTICIPANTS

In tables 4, 5, 6, and 7, the general data is shown for all respondents, divided into socio-demographics, physical, social information, and information on the current walking route to the supermarket. Some percentages do not add up to 100%, as for some questions multiple answers are possible (e.g. household or walking aid).

Within the socio-demographic data of all respondents, table 4 shows that the percentage of male is relative high in comparison to female, especially in comparison to the whole population in the Netherlands. From the age of 65 and over, there is a slightly higher percentage of females in the Netherlands. With increasing age, the percentages of women increases more compared to males (CBS, 2021a). So, the ratio male to female in this experiment is not representative for the rest of the Netherlands.

For the age groups in this experiment, almost 50% has the age of 75+. The other 50% is distributed equally over the other two age groups. For the household composition, the percentages of people that live alone is corresponding to the average Dutch household composition of this age group (CBS, 2021b). Finally, 93% of the participants are retired, as expected.

Table 4_ Socio-economic data

	Characteristic	**% sample (408 resp.)**
Age	65-69	27%
	70-74	25%
	75+	48%
Gender	Male	62%
	Female	38%
Urban area	Highly urbanized (level 1)	24%
	Strongly urbanized (level 2)	49%
	Moderately urbanized (level 3)	27%
Household	Alone	28%
	Partner	71%
	Child	5%
Dwelling type	Rental	44%
	Owner-Occupied	56%
Education	Low	33%
	Middle	38%
	High	29%
Retired	Yes	93%

The physical data, table 5, shows that only 16% uses some type of walking aid, and 23% is not able to walk more than 15 minutes without having to take a break. Some questions were asked about how much effort it took for someone to get up or sit down from a chair or bench, as well as the effort to enter or leave their dwelling, and it shows that 10% of the participants has difficulty leaving or entering their home, which might influence their choice to order groceries online. The physical data furthermore shows that 37% of the participants walks to the supermarket less than once a week, and 30% walks less than once a week in general (to anything other than the supermarket).

Table 5_ physical data

	Characteristic	**% sample (408 resp.)**
Walking aid	Uses walking aid	16%
	Wheelchair	2%
	Rollator	8%
	Walking stick	7%
	Walker	1%
	Scooter	3%
Effort sit	Great effort	1%
	Some effort	29%
	Without effort	70%
Effort dwelling	Great effort	0%
	Some effort	10%
	Without effort	90%
Max walking distance (without a break)	Max 5 min.	7%
	Max 15 min.	16%
	Max 30 min.	13%
	Max 45 min.	11%
	More than 45 min.	53%
Walking frequency to supermarket	Less than once a week	37%
	Once or twice a week	44%
	3 or 4 times a week	15%
	5 or more times a week	3%
Walking frequency other	Less than once a week	30%
	Once or twice a week	35%
	3 or 4 times a week	18%
	5 or more times a week	18%

The social data, table 6, shows that only 9% of the participants feels regularly lonely (and 14% feels lonely sometimes) and 11% of participants indicates a 6 or lower for their life satisfaction on a scale from 1 to 10 (10 being very satisfied). In the introduction of this report is stated that in the Netherlands roughly 50% of people in the age group 65+ feels socially lonely (De Staat van Volksgezondheid en Zorg, Eenzaamheid, 2016). So the data in this experiment is not in line with the national data, which might have a couple of reasons. First of all, it is very difficult to measure when a person feels socially lonely, so a different method or question can lead to different results. Second, the survey was distributed digitally. Many elderly people do not own a computer and were therefore excluded from this experiment. It could be possible that the participants in this experiment have lower levels of loneliness as usage of computer technology can potentially lead to reduced loneliness among elderly (Chopik, 2016).

Lastly, in this experiment, we are only looking at elderly in urbanized areas. Urbanization might be correlated to mental well-being. In urbanized areas the social networks of elderly might still be within a distance that they can travel easily, resulting in possible higher social emotional state of the participants. In the Netherlands, currently there is a trend of elderly moving out of those urbanized areas (Broek, 2018). A lot of the nursing homes are therefore located outside of urbanized areas, excluding these elderly from this research as well.

In order to still use the this social data later on, the three questions on loneliness, contact outside of household, and turn to people when needed, are combined into one social value. All three values were measured on a 5 point Likert-scale (strongly disagree to strongly agree). These are converted into numerical values of 1 having high social value and 5 low social value, and then averaged to find a general social value. The average of this social value for all respondents is 2.0 with a standard deviation of 0.7, indicating that the social value is average-to-good for the respondents of this experiment.

As for the social purpose of grocery shopping, 8% of elderly go grocery shopping to actually see other people. Other reasons (besides getting groceries) are to stay active (15%) or to have something to do (6%).

Table 6_ Social data

	Characteristic	**% sample (408 resp.)**
Satisfaction life	Low (1-6)	11%
	Average (7-8)	71%
	Good (9-10)	16%
Regular contact outside of household	Yes	79%
	Medium	13%
	No	8%
I can turn to others when needed	yes	80%
	Medium	14%
	No	5%
Regularly feel lonely	Yes	9%
	Medium	14%
	No	77%
Grocery shopping	Alone	47%
	With someone else	43%
	Someone else does them for me	3%
	Online	6%
Purpose grocery shopping	To get groceries	96%
	To stay active	15%
	To see other people	8%
	To have something to do	6%

Finally, looking at their current route to the supermarket, the participants were asked to indicate how satisfied they were with their current route, shown in table 7. In an open follow-up question was asked to explain why. For the people that were either neutral (17%), unsatisfied (4%) or very unsatisfied (1%), the disadvantages of the routes can be classified and are shown in the overview in table 8.

This shows that the main reason to not be satisfied with their current route is because of the bad pavement quality (cracks, holes, or bad maintenance) and long walking distances. The pavement width and resting points, two other physical attributes of this research, have also been mentioned a couple of times, as well as the boring route, which might correspond to the restorative attribute of scenery. Two disadvantages mentioned, that are not researched upon in this stated choice experiment, are too much traffic and dangerous crossings.

Table 7_ Supermarket data

	Characteristic	% sample (408 resp.)
Distance supermarket	5 minutes or less	13%
	5 to 15 minutes	65%
	15 to 30 minutes	18%
	30 minutes or more	4%
Satisfaction current route supermarket	Very satisfied	31%
	Satisfied	48%
	Neutral	17%
	Unsatisfied	4%
	Very unsatisfied	1%
Satisfaction public space at supermarket	Very satisfied	17%
	Satisfied	56%
	Neutral	22%
	Unsatisfied	4%
	Very unsatisfied	1%
Benches on route	At least 1 bench on route	35%
	No bench	65%

Table 8_ Overview negative comments on current route towards the supermarket

Disadvantages of current route towards the supermarket	Amount of respondents
Bad quality pavement	12
Distance too long	11
Too much traffic	5
Not enough space on pavement (or too many obstacles)	5
Boring route	5
Not enough resting points on route	4
Dangerous crossing	3

6. Discrete choice model

In this chapter, a discrete choice model is executed to analyse the data. First, a multinomial logit model is executed to find the preferences of elderly. Then, a latent class model is executed to find heterogeneity within the group of elderly. Since heterogeneity is found within the latent class model, cross effects were calculated within the MNL model for socio-demographic variables, variables with mobility restrictions, social variables, and finally some variables on supermarket data.

6.1 MULTINOMIAL LOGIT MODEL

A multinomial logit model (MNL) is executed to see how the attributes influence the preferences. For the attributes ‘pathway type’, ‘pathway width’, and ‘Bench on route’ the attribute level 0 from table 3 (chapter ‘visualizations’) are used as the reference level. These are chosen because they represent the most commonly used options in reality. The coefficients therefore refer to the optimal attribute level according to the literature, and will be positive. For the attribute ‘scenery’, there are three attribute levels. ‘Neighbourhood with green’ is used as the reference level, as this is the intermediate level. As explained in the hypotheses of chapter 3, ‘Green’ is expected to be positive, and ‘neighbourhood without green’ is expected to be negative. For ‘distance’, the attribute level of ‘5 minutes’ is used as the reference level. When the travel distance increases from 5 minutes to 15 minutes, the coefficient is expected to be negative, as it costs more effort. Finally, the ‘not’ option, when people choose neither of the routes and rather have groceries delivered to their house, is expected to be negative, since people rather walk to the supermarket than to order online.

Table 9 shows the results for the whole sample . It can be seen that all coefficients are highly statistical significant ($p<0.001$), except for ‘neighbourhood without green’, which is not statistical significant at all. When rerunning the model with ‘neighbourhood without green’ as the reference, the coefficient for ‘green’ is the same. Furthermore, all signs of the coefficients are as to be expected; distance and ‘not’ (and neighbourhood without green) are negative, and all others are positive. The attribute level ‘green’ for the restorative attribute ‘scenery’ has the highest utility, followed closely by ‘distance’. Next are the physical attributes of ‘pathway type’, followed by ‘pathway width’, and finally ‘benches on route’.

The final column of table 9 shows the willingness to pay (WTP), or in this case willingness to walk. Using equation 4, the WTP gives an indication on how much more time the elderly are willing to walk when a certain attribute level is added to the route compared to the reference situation.

As can be seen in the last row of table 9, the rho square of the MNL model equals 0.022. This value is too low, as it should be higher than 0.2 to be a good fit. It should be mentioned that within social and behavioural sciences though, the R squared is generally lower, since it is difficult to predict how people react (Itaoka, 2012). According to Ozili (2022) though, r square values between 0 and 0.09 should still be rejected, even in social researches.

The most obvious reason for such low value is likely to be the lack of additional explanatory variables to predict the dependent variable (Ozili, 2022; Itaoka, 2012; Moksony, 1999). Moksony (1999) however argued that a low r square does not mean that the results of the model cannot be used. He explains that when the aim of the research is to establish a causal relationship, the R square could be irrelevant when there is no intent to create a full list of causes. It simply indicates that besides the independent variables tested in the research, there are additional variables that affect the dependent variable as well (Moksony, 1999). As explained before, since this stated choice experiment consisted of images, only four independent variables could be included to avoid an overkill of information in one choice set. Therefore many attributes that could influence the willingness to walk are not included in this research, including all attributes listed in table 1 and 2 in section 2.6 of this report. This might explain such low R square. Other reasons could include; correlations between explanatory variables, sample size, structural form of the model, or even the whole model estimation method (Ozili, 2022). Since the coefficients are statistically significant, the results can still be used to determine the preferences of elderly on their daily walking route and their willingness to walk.

Table 9_ Results of MNL model

Attribute	**Levels**	**Coeff MNL**	**Std. error**	**WTP (time)**
Distance	15 min.	-0.499	(0.071) ***	10 min.
	5 min.	0.000		
Scenery	Neighbourhood without green	-0.029	(0.074)	
	Neighbourhood with green	0.000		
	Green	0.526	(0.083) ***	10.5 min
Pathway type	Tiles	0.000		
	Asphalt	0.471	(0.067) ***	9.4 min.
Pathway width	Small	0.000		
	Wide	0.356	(0.078) ***	7.1 min
Bench on route	No	0.000		
	Yes	0.307	(0.066) ***	6.2 min
Not		-1.449	(0.120) ***	
Rho square		0.022		

*Significance: *p<0.1; **p<0.05; ***p<0.01*

Within the MNL model, it is assumed that the group of participants is homogeneous. However, in reality it is expected that the group of elderly is heterogenous and these different groups have different needs and wishes. Two methods are executed to test this heterogeneity: (1) latent class model, and (2) attribute cross effects in the MNL model. Section 6.2 will explain the results of the latent class model and section 6.3 the cross effects.

6.2 HETEROGENEITY LATENT CLASS MODEL

A latent class model is run with two classes. Table 10 and figure 24 show the results. The main difference between the two classes can be found for the 'not' value. For class 1, distance is relatively more important, and this class prefers to order their groceries online. The physical attribute of the presence of a bench on the route is also important. Elderly in class 2 on the other hand prefer to get their groceries themselves, and are less inclined to order them online. A green route is important, but not much more important than the physical attributes. It is expected that elderly in class 1 have some type of mobility restriction, and they might not be able to physically walk to the supermarket as easily as the elderly in class 2.

In the last row of table 10, a value is given for class 2. Using formula 6 (Sarrias, 2022), it can be calculated from the value how much of the respondents is more sensitive to belong to class 2. Formula 6 gives a value of 0.84274 for the latent class model, indicating that 84% of the respondents is likely to belong to class 2.

$$(6)\ Share\ for\ class\ 2 = \exp\ (coef\,[(\text{class})2"])\ /\ (\exp(0) + \exp(\text{coef}[(\text{class})2"]))$$

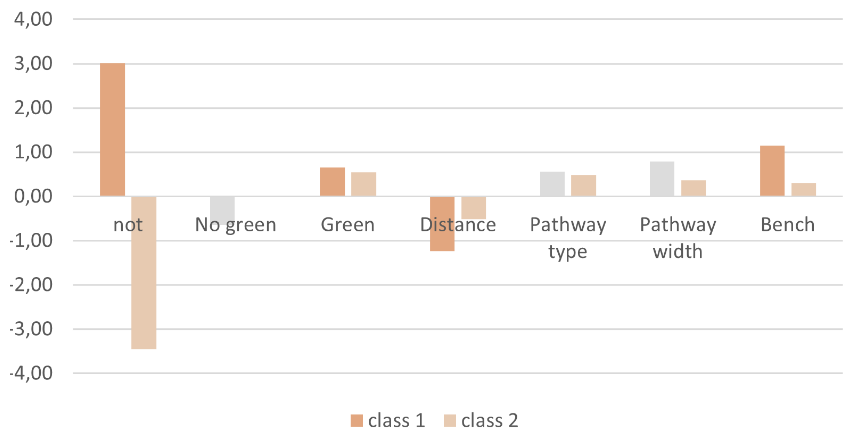
It should be noted that there is no R square value for the latent class models or amount of people belonging to a certain class. This is related to some issues in RStudio where the execution of the model kept giving errors. Due to lack of time, it was not possible to solve these issues. The results of the latent class model are however only used as an indication that the target group of elderly is heterogeneous. The cross effect model in section 6.3 further elaborates how the heterogeneousness in the target group can be classified.

Table 10_ Latent class model (Q=2)

Attribute	**Levels**	**Coeff Class 1**	**Std. error**	**Coeff Class 2**	**Std. error**
Distance	15 min.	-1.231	0.414 **	-0.509	0.075
	5 min.	0.000			
Scenery	Neighbourhood without green	-0.650	0.452	-0.010	0.077
	Neighbourhood with green	0.000			
	Green	0.658	0.388 .	0.540	0.088 ***
Pathway type	Tiles	0.000			
	Asphalt	0.557	0.351	0.485	0.070 ***
Pathway width	Small	0.000			
	Wide	0.786	0.493	0.360	0.082 ***
Bench on route	No	0.000			
	Yes	1.147	0.461 *	0.300	0.069 ***
Not		3.013	0.621 ***	-3.452	0.279 ***
(Class) 2				2.372	0.084 ***

*Significance: *p<0.1; **p<0.05; ***p<0.01*

Figure 24_ Latent class model (Q=2) (grey is not statistically significant)



By executing a latent class model including various variables of elderly , it can be tested if the hypothesis of the class differences described above is true. The variables of elderly are created using all personal questions in the questionnaire to create these groups. Table 11 shows the results.

Table 11_ Latent class model socio- demographics (Q=2)

Attribute	**Levels**	**Coeff Class 1**	**Std. error**	**Coeff Class 2**	**Std. error**
Distance	15 min.	-1.186	***	-0.484	***
	5 min.	0.000			
Scenery	Neighbourhood without green	-0.935	*	0.011	
	Neighbourhood with green	0.000			
	Green	0.471		0.551	***
Pathway type	Tiles	0.000			
	Asphalt	0.510		0.493	***
Pathway width	Small	0.000			
	Wide	0.360		0.371	***
Bench on route	No	0.000			
	Yes	0.991	**	0.297	***
Not		2.552	***	-3.754	***
(Class) 2				1.875	
Age 75+				0.139	
Gender_Female				-0.477	
Urban extreme				0.201	
HH Alone				0.804	
HH Partner				1.066	
Rental HA				-0.063	
Low education				0.770	*
Retired				0.847	.
Rollator				0.669	
Walking stick				1.103	
Walking aid				0.794	
Effort sit some				0.129	
Effort dwelling some				0.003	
Max walk 15 min				-0.737	
Freq. walk superm. 0				-1.031	***
Freq. walk other 0				-0.774	*
Walking restrictions				0.362	
Physical restrictions				-3.749	***
Low life satisfaction				-0.997	**
Social contact no				-0.170	
Social people no				0.745	
Social lonely yes				-0.867	
Grocery shop with someone				1.575	***
Purpose stay active				0.805	
Purpose see others				-0.858	
Distance supermarket long				-0.750	**
Satisf. route superm. low				-2.237	***
Benches routes no				0.510	
Satisf. public space low				0.814	

*Significance: *p<0.1; **p<0.05; ***p<0.01*

A value is again given for (class) 2. Using formula 6 results in a value of 0.76528 for the share of class 2 of this latent class model, meaning that 77% of the elderly in this research are likely to belong to class 2. This value is however not significant and thus no conclusions can be made for the share of class 2 for this model.

The variables with negative values are most likely to belong to class 1 (as they are positive for class 2), and the variables with positive values are most likely to belong to class 2. The elderly of class 1 are more inclined to order their groceries online, and as stated before it is expected that elderly with some kind of mobility restriction belong to this class. Table 11 shows that this is partly true, as elderly with physical restrictions have relative high value for class 1 and people in this group are thus very likely to be part of class 1 and order online. Other elderly that are likely to belong to this class are those elderly with low walking frequency, which for them also makes sense to prefer to order online rather than to walk. Furthermore, people with low life satisfaction are likely to be part of this class. This was not directly hypothesized, however when looking at the data of these people, 50% of this group with low life satisfaction also encounters some kind of mobility restriction or is not able to walk more than 15 minutes. So, physical and mental wellbeing might to some extend be related to one another, and then the results of this latent class model are as expected. Finally, people with low satisfaction for the route towards the supermarket, or people where the distance to their supermarket is relatively long are also likely to be part of class 1 and order their groceries online, which can be expected as well.

Class 2 consists of the groups of elderly that is more likely to physically walk to the supermarket to get their groceries. According to the latent class model, elderly with low education are very likely to belong to this class, which was not as expected. Furthermore, those elderly that are retired are likely to be part of this class 2, which is in line with the fact that these people have more time and are thus more likely to see grocery shopping as a daily activity and rather walk to get groceries than order online. Elderly that go grocery shopping with someone else are also likely to be part of class 2, which makes sense, as they see grocery shopping as a social activity as well as a functional activity. Finally, for those elderly that have no benches on the route are likely to be part of class 2 as well, which is not as expected. It might however be the case that the elderly in class 2 have no mobility restrictions what so ever, and are thus not in need of a bench on the route.

The latent class model showed that there is high heterogeneity within the group of elderly and they can be classified mainly based on which groups are willing to walk for their groceries and which are more likely to order online. In order to get a more in depth insight into the preferences of different variables, the cross effects for each of these variables will be analysed in the following section.

6.3 HETEROGENEITY CROSS EFFECTS MNL

In order to find heterogeneity within the group of elderly, cross effects are tested for smaller groups of elderly within the main sample, again based on the personal questions in the questionnaire. A loop list of these variables are created in RStudio in which all elderly variables are tested for the MNL within the whole target group to see if different groups of elderly also have different preferences for public space design. The variables can be divided into groups of socio demographics, mobility restrictions, social restrictions, and finally the current route towards the supermarket. First some hypotheses are set for these variable, whereafter will be checked if the hypotheses are correct or should be rejected using the MNL model. Table 12 shows the expected cross effects in an overview, which will be explained separately in the following sections.

Table 12_ Hypotheses cross effects

Category	Variable	Attribute	Expected cross effect
Socio-demographics	Age 75+	Distance	- -
		Not	+
	Urban extreme	Distance	- -
		Not	+
	HH alone	Pathway width	-
		Green	+
	Retired	Distance	+
Mobility restrictions		Distance	- -
		Pathway type	+
		Bench	+ + +
		Not	+ +
	Wheelchair, scooter	Bench	- -
	Walking aid	Pathway width	+
Social	Low life satisfaction, lonely	No green	- -
		Green	+++
		Distance	-
		Not	+
	Purpose_ stay active	Green	+
		Distance	+ +
		Not	-
Supermarket	Low satisfaction current route to supermarket	Green	+
		Distance	- -
		Not	+ +

6.3.1 Socio demographics

Within the socio demographics groups of elderly it is expected that the age group of 75 and over have a negative cross effect for 'distance', as these people are likely to have more difficulties while walking and thus prefer shorter routes. They however are not very likely to order their groceries online, as this age group is less familiar with this type of grocery shopping. Another expectation for distance is for those elderly living in extremely urbanized areas, who are also expected to have a negative cross effect, as they are used to have their facilities closer to home. Furthermore, for household composition it is expected that people that live alone have a slightly negative cross coefficient for 'pathway width', as they do not have the need to walk next to someone else. Furthermore, 'green' is expected to have a positive cross effect because of its restorative value. Finally, elderly that are retired are expected to have a positive cross effect for 'distance', since these seniors have more time to spend, distance is less important to them.

Appendix E.1 includes an overview of all the MNL cross effects. Appendix E (and the highlighted groups in this chapter) all show the R square values as well. Even though all R square values of the different elderly groups are higher than the regular MNL model, they are still too low and therefore the models should be rejected. As explained before though, the R square is less of importance within this research, so the models can still be used to determine the preferences of specific elderly target groups on their daily walking routes focusing only on the attributes researched upon here. So, there might be some additional variables that can influence their choice and willingness to walk.

In table 13, shown on page 56, some interesting results are highlighted, namely the binary variables of age, retirement, and gender. As expected, people that live in extremely urbanized areas show a negative cross effect for distance, indicating that they do not prefer to walk longer distances. For the age group of 75 + though, the opposite is true, shown in table 13. This group has a positive cross effect for distance, meaning that distance is less important to them.

The overall coefficient for this age group would still be negative, so people aged 75+ prefer to have shorter distance, but the other attributes are more important to them. For the group of elderly that is retired, there can be found a positive cross effect for distance even larger than the regular coefficient, meaning that for this group distance is not important at all. A striking observation for this group though is that green has a negative cross effect, even larger than the regular coefficient for green. Meaning that for this group, a green environment is less important. An explanation for this result is that people that are retired might be less stressed, and thus do not need a restorative environment.

Striking observations that were not hypothesized can be found for the groups of females and low education. For females, many differences can be found, namely for green and pathway type that have a positive cross effect, resulting in higher preference for these attributes. Pathway width on the other hand is less important, and females are also more inclined to order groceries online. Furthermore, people with low education have a negative cross effect for green, which makes green less important for them. Finally, people that live alone value the presence of a bench lower.

6.3.2 Mobility restrictions

In general people with any kind of mobility restrictions are expected to have a positive cross effect for ‘not’, as these people might be more inclined to order their groceries online when the physical task costs too much effort. In line with that, positive cross effects are expected for pathway type and bench, as uneven pathway type may form obstructions and they need to rest more often. The attribute of a bench is expected to be negative though for walking aids of wheelchair and rollator, as they are not in need of a bench. For these walking aids, pathway width is then expected to have a positive cross effect, as they might need more space free of obstacles in order to move around easily. The group of people with mobility restrictions is split up in those groups with a certain walking aid, the effort it takes to sit or leave the dwelling, and those people that can walk a maximum distance of 15 minutes.

Appendix E.2 includes the overview of the results of the MNL cross effects for the mobility restrictions. Some of these results were very interesting and are therefore shown in Table 14 shows as well (page 57), including elderly that use a walking stick, elderly where it takes some effort to sit down or get up, and finally elderly that can only walk a maximum distance of 15 minutes without having to take a break. First of all, for the group of people with a walking aid, there are some differences between specific walking aids. The whole group only has a cross effect for not, which increases, meaning that this group is more inclined to order their groceries online, as expected. When looking at the specific walking aids, only rollator and walking stick were tested for cross effects, as these have more than 20 respondents. Even though both groups have a positive cross effect for ‘not’, elderly with a walking stick have a negative cross value for distance. This indicates that even though they are more inclined to order their groceries online, distance is less important to them while walking, not as expected. This group also has a negative cross effect for neighbourhood without green, which was not expected, but it is still in line with the restoration theory. Finally, this group does not show a statistically significant increase for the bench attribute, which is not in line with the expectations.

For those people where it requires some effort to sit or to leave the dwelling do have higher cross effects for the attributes of pathway type, bench on route and ‘not’, all three as expected, as these elderly are expected to have issues with walking in general and might not be able to walk over uneven pathway or need to rest more often. They furthermore have a negative cross effect for no green.

This was not necessarily expected, but it does make sense in the whole restoration theory of green having a positive effect on the mental well-being and stress levels, which might be higher for people with physical restrictions.

Finally, the group of people that can only walk a maximum distance of 15 minutes without taking a break have a high positive cross value for ‘not' and a negative cross value for distance, as expected. These people prefer to order groceries online and if they do walk, a short distance is preferred. Benches are preferred and have relative high value in comparison to the other attributes, which might make it possible to travel larger distances. This group of people is willing to walk an extra 11 minutes when benches are added to the route. Furthermore, a negative cross effect is found for no green for this group, which again is in line with the restoration theory.

6.3.3 Social restrictions

The social restrictions are measured by looking at the life satisfaction on a scale of 1 to 10 (1 being low life satisfaction), as well as some other factors that might define ones mental wellbeing, such as social network. Since the latter has quite low amount of respondents (as explained before), the average is taken of the three social questions about contact with people outside of their household, people to turn to, and loneliness, on a Likert-scale from 1 to 5 (1 has the highest values for few contacts and loneliness). It is expected that people with a low life satisfaction or high levels of the average variable have a positive cross effect for a green route, as restoration might have an higher impact. Physical attributes might therefore be less important. Furthermore, the distance is expected to be slightly negative, as these people might not be inclined to walk far for their groceries, which is also why ‘not' is expected to be slightly positive.

Appendix E.3 includes the full overview of the MNL cross effects for elderly with social restrictions as well. Table 15 shows some of the most interesting results (page 58), namely those elderly that indicated that they have a life satisfaction of 6 or lower, and the variable of social average, explained above. First of all, life satisfaction is tested in two ways; the group with low life satisfaction are those people that rated their life satisfaction as a 6 or lower (on a scale from 1, low life satisfaction, to 10, very satisfied). There is only a cross effect for ‘not', which is positive, as expected. When running the cross effect on the scale itself, it shows that with one satisfaction point increasing, the distance become less important, and people are more willing to walk rather than to order online. So, the more satisfied elderly are with their life, the longer they are willing to walk.

When looking at the other social indicators, it shows that each point increase, the distance becomes more important, and people are more inclined to order online. So, the more issues elderly have with social well-being, they are less likely to walk, which is similar to the results of life satisfaction.

Table 13_ Cross effects socio-demographics

		Coeff. base MNL (std. Error)	Coeff. Age 75+ (std. error)	Coeff. Retired (std. error)	Coeff. Female (std. Error)
Scenery	L1 Neighbourhood Without green	-0.029 (0.074)	-0.037 (0.103)	-0.177 (0.302)	-0.041 (0.093)
	X person variable		0.016 (0.149)	0.152 (0.312)	0.021 (0.155)
	L2 Green	0.526 (0.083) ***	0.596 (0.116) ***	1.144 (0.345) ***	0.375 (0.103) ***
	X person variable		-0.139 (0.166)	-0.661 (0.356) *	0.386 (0.175) **
Distance	L1 15 min	-0.499 (0.071) ***	-0.649 (0.100) ***	-0.998 (0.302) ***	-0.487 (0.091) ***
	X person variable.		0.306 (0.142) **	0.535 (0.310) *	-0.046 (0.147)
Pathway type	L1 Asphalt	0.471 (0.067) ***	0.551 (0.096) ***	0.459 (0.293)	0.293 (0.084) ***
	X person variable		-0.152 (0.134)	0.013 (0.301)	0.482 (0.141) ***
Pathway width	L1 Wide	0.356 (0.078) ***	0.342 (0.107) ***	0.304 (0.305)	0.465 (0.099) ***
	X person variable		0.031 (0.156)	0.053 (0.316)	-0.271 (0.162) *
Bench on route	L1 Yes	0.307 (0.066) ***	0.325 (0.089) ***	0.597 (0.269) **	0.333 (0.083) ***
	X person variable		-0.033 (0.133)	-0.315 (0.277)	-0.071 (0.138)
not		-1.449 (0.120) ***	-1.446 (0.165) ***	-1.008 (0.438) **	-1.761 (0.162) ***
	X person variable		0.004 (0.241)	-0.479 (0.455)	0.757*** (0.245)
# respondents		100%	48%	93%	38%
ρ^2		0.022	0.025	0.039	0.022

*Significance: *p<0.1; **p<0.05; ***p<0.01*

Table 14_ Cross effects mobility restrictions

		Coeff. base MNL (std. Error)	Coeff. Walking stick (std. error)	Coeff. Effort sit some (std. error)	Coeff. Max walk 15 min. (std. Error)
Scenery	L1 Neighbourhood Without green	-0.029 (0.074)	0.008 (0.077)	0.080 (0.088)	0.046 (0.083)
	X person variable		-0.501 (0.308)	-0.411 (0.167) **	-0.409 (0.187) **
	L2 Green	0.526 (0.083) ***	0.539 (0.086) ***	0.518 (0.098) ***	0.550 (0.094) ***
	X person variable		-0.196 (0.346)	0.017 (0.185)	-0.089 (0.202)
Distance	L1 15 min	-0.499 (0.071) ***	-0.463 (0.073) ***	-0.493 (0.084) ***	-0.420 (0.080) ***
	X person variable.		-0.681 (0.331) **	-0.032 (0.159)	-0.350 (0.177) **
Pathway type	L1 Asphalt	0.471 (0.067) ***	0.455 (0.069) ***	0.399 (0.079) ***	0.430 (0.075) ***
	X person variable		0.424 (0.323)	0.279 (0.151) *	0.187 (0.168)
Pathway width	L1 Wide	0.356 (0.078) ***	0.357 (0.081) ***	0.340 (0.092) ***	0.358 (0.088) ***
	X person variable		-0.083 (0.324)	0.047 (0.175)	-0.028 (0.194)
Bench on route	L1 Yes	0.307 (0.066) ***	0.296 (0.068) ***	0.211 (0.077) ***	0.210 (0.074) ***
	X person variable		0.167 (0.284)	0.351 (0.150) **	0.561 (0.167) ***
not		-1.449 (0.120) ***	-1.536 (0.127) ***	-2.070 (0.159) ***	-2.171 (0.162) ***
	X person variable		1.004 (0.435) **	1.736 (0.260) ***	2.160 (0.280) ***
# respondents		100%	7%	29%	16%
ρ^2		0.022	0.051	0.038	0.139

*Significance: *p<0.1; **p<0.05; ***p<0.01*

Table 15_ Cross effects social restrictions

		Coeff. base MNL (std. Error)	**Coeff. Low life satisfaction (std. error)**	**Coeff. Social average (Likert scale) (std. error)**
Scenery	L1 Neighbourhood Without green	-0.029 (0.074)	0.013 (0.080)	-0.027 (0.219)
	X person variable		-0.333 (0.226)	0.000 (0.106)
	L2 Green	0.526 (0.083) ***	0.529 (0.088) ***	0.317 (0.247)
	X person variable		-0.060 (0.261)	0.108 (0.119)
Distance	L1 15 min	-0.499 (0.071) ***	-0.460 (0.076) ***	-0.030 (0.210)
	X person variable.		-0.345 (0.220)	-0.242 (0.102) **
Pathway type	L1 Asphalt	0.471 (0.067) ***	0.469 (0.071) ***	0.587 (0.198) ***
	X person variable		0.036 (0.209)	-0.060 (0.095)
Pathway width	L1 Wide	0.356 (0.078) ***	0.385 (0.084) ***	0.604 (0.232) ***
	X person variable		-0.285 (0.236)	-0.126 (0.113)
Bench on route	L1 Yes	0.307 (0.066) ***	0.308 (0.071) ***	0.293 (0.194)
	X person variable		0.005 (0.202)	0.004 (0.094)
not		-1.449 (0.120) ***	-1.647 (0.135) ***	-2.203 (0.360) ***
	X person variable		1.056 (0.322) ***	0.348 (0.165) **
# respondents		100%	11%	100%
ρ^2		0.022	0.061	0.027

*Significance: *p<0.1; **p<0.05; ***p<0.01*

6.4 CONCLUSION MNL

The results of the MNL show that the most important attribute on their daily walking route to the supermarket is to have a green route, followed closely by the physical attribute of pathway type. The latent class models though shows that there is heterogeneity within the target group of elderly that determine whether they prefer to walk to the supermarket or stay home and order online.

When looking at the separate groups of variables, it shows that within the socio demographic group, mainly differences were found for females and some differences within household compositions. When specifically zooming into those elderly that encounter some type of mobility restriction, they are willing to walk less and are more likely to order their groceries online. The presence of a bench on the route becomes very important though as they might need to rest. Furthermore, some variables show a negative result for a route without any green, showing that restoration is still very important for these elderly.

For the group of elderly with reduced social health, not much can be said in general, as most results are not statistical significant. It can be concluded though that with increasing social health issues, they are less willing to walk and more likely to order their groceries online. However, just because the results are not statistical significant does not mean that there are no cross effects for the restorative or physical attributes. As explained before, this is only a small group of people that has lower stated mental well-being in this experiment. It is very likely that this is the reason that there are no statistical significant cross effects. It would therefore be interesting to look at this specific group of elderly in particular, as it is expected that the social attribute of green is more important.

7. Ordinary Least squares

In this chapter an OLS will be executed to find the willingness to walk of elderly in general and how certain attributes can influence the willingness to walk. Then, the same variables as the MNL model are used to find the cross effects within the OLS to see the differences between groups of elderly. Our data are left-sensored, so additionally to an OLS, in further research a tobit model can be used. See Ossokina et al. (2022).

7.1 REGULAR MODEL

As explained before, participants were asked how long they were willing to walk along each of the presented routes in the discrete choice model. From this information can be derived how long the elderly are willing to walk in general and how the attributes might affect that. This model differs from the MNL model in a couple of ways. First of all, the element of walking to the supermarket is removed, and participants were only asked how long they were willing to walk along the routes in general. Furthermore, the attribute of “distance” is not part of this question, and is replaced by the maximum walking time, which is then used as the preference variable. The independent variables are the social and physical attributes that we are interested in. To determine whether the data can be used for an OLS, the data is first plotted, as shown in figure 25. Figure 25.a show the plot of residual vs fitted, indicating that the data is indeed linear, as the residuals are averaged around the zero line . The plot in figure 25.b shows that the residuals have a normal distribution. Thus, the regular OLS can be executed.

Figure 25_ OLS plotted (25.a: Residual vs Fitted, 25.b: normal distribution)

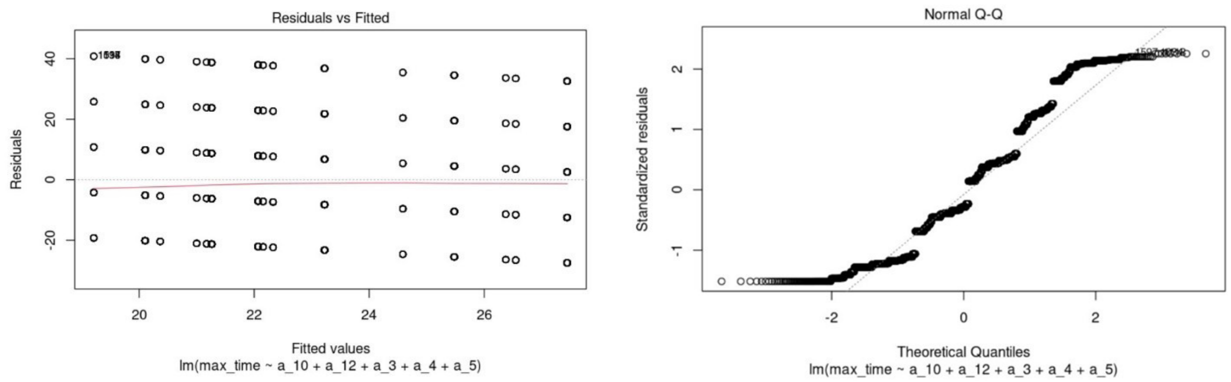


Table 16 shows the results of the OLS. Even though ‘neighbourhood without green’ was not statistical significant in the MNL model, it is statistical significant for the OLS and indeed shows the expected negative sign. ‘Pathway width’ and ‘bench on route’ were however not statistically significant. When interpreting the statistical significant results it shows that elderly are willing to walk 20 minutes for their daily walk in the reference baseline scenario. When the route goes through the neighbourhood without any green, they are willing to walk 19 minutes, and when the route goes through green, they are willing to walk 25 minutes. When the pathway is asphalt instead of tiles, elderly are willing to walk an extra 2 minutes.

Table 16 also gives the R square value for the OLS model, which is 0.019, and is even slightly lower than the MNL model. This low value can again be explained by the missing explanatory variables of the model. Since, the goal for this OLS is similar to the goal of the MNL, the results of this analysis can still be used to determine preferences of attributes as explained in section 6.1 in this report.

Table 16_ Results of OLS

Attribute	**Levels**	**Coeff MNL**	**Std. error**
Constant		20.3664	0.740 ***
Scenery	Neighbourhood without green	-1.156	0.673 *
	Neighbourhood with green	0.000	
	Green	4.218	0.708 ***
Pathway type	Tiles	0.000	
	Asphalt	1.9624	0.581 ***
Pathway width	Small	0.000	
	Wide	0.8982	0.624
Bench on route	No	0.000	
	Yes	0.8908	0.612
Rho square		0.019	

*Significance: *p<0.1; **p<0.05; ***p<0.01*

As explained before, these results cannot be directly compared to the results of the MNL model, as the questions were different. But we can derive the effect of the attribute levels, especially for the restorative attribute of scenery, as it was not statistically significant in the MNL. And it shows that green indeed has a statistical significant influence on the willingness to walk for elderly. A route that is green has highest positive impact, but even adding some green elements like trees to the neighbourhood has a positive influence.

In the MNL model, the coefficients of the restorative and physical attributes are relative close to one another, indicating that all attributes are important. In the OLS it shows that restoration has a much bigger influence. The value of a green route is four to five times higher than pathway width and benches, and twice as high for no green and pathway type, showing the importance of restoration for the elderly population.

7.2 HETEROGENEITY CROSS EFFECTS

Similar to the MNL model, cross effects can be tested in the OLS as well for different variables. The hypotheses on the attributes explained in chapter 6 remain the same here, but since 'not' and distance are not measured in the OLS, the hypotheses are reduced to the overview in table 17. Similarly to the MNL results, the full overview of all cross effects are shown in appendix F, this section shows the important results which are discussed.

Table 17_ Hypotheses cross effects

Category	Variable	Attribute	Expected cross effect
Socio-demographics	HH alone	Pathway width Green	- +
Mobility restrictions	General	Pathway type Bench	+ + + +
	Wheelchair, scooter	Bench	- -
	Walking aid	Pathway width	+
	Low walking frequency	Physical attribute	+
Social	Low life satisfaction, lonely	No green Green	- - +++
	Purpose_ stay active	Green	+
Supermarket	Low satisfaction current route to supermarket	Green	+

7.2.1 Socio demographics

Within the socio demographics groups of elderly it is expected that green will have a positive cross effect for people in a single household, as they might value restoration more.

When running those same variables in the OLS model, different cross values can be found for the 'constant', which increases or decreases the amount of time elderly are willing to walk. Appendix E.1 shows an overview of all results of the cross effects of the OLS for the socio-demographics variables, and table 18 (page 63) highlights some of the most interesting variables, namely the group of elderly older than 75 years, those elderly that live by themselves without anyone else, and finally those elderly that still live with a partner. The results show that elderly generally are willing to walk roughly 20 minutes on average. The age group of 75+ is willing to walk a little less, shown in the cross effect of the constant. A bigger cross effect can be found for household composition though, as elderly that live alone are willing to walk less, and elderly living with a partner are willing to walk more.

7.2.2 Mobility restrictions

For the group of elderly with some kind of mobility restriction, the OLS cross effects are tested as well. All results of the OLS cross effects for those elderly with any kind of mobility restriction are shown in appendix E.2, but table 19 (page 64) shows some of the interesting results as well, including those elderly that use a walking stick, those elderly where it requires some effort to enter or leave their dwelling, and those elderly only able to walk a maximum of 15 minutes without having to take a break. The most striking results can be found in the general willingness to walk again, so the 'constant', which is on average much lower for elderly with any kind of mobility restriction. For people with a walking aid the willingness to walk (with all attributes having the base value) is 12 minutes, and people that can walk less than 15 minutes without taking a break are only willing to walk 7 minutes.

Besides the willingness to walk in general, the model also shows that for people with a walking stick and for people where entering or leaving their dwelling costs some effort, there is a positive cross effect for a green route. This was not hypothesized, but is in line with the restoration theory. So, this might be an indication that people with certain mobility restrictions experience more stress or fatigue in life and therefore benefit from a restorative environment in general.

Table 18_ Cross effects socio-demographics

		Coeff. base OLS (std. Error)	**Coeff. Age 75 + (std. error)**	**Coeff. HH Alone (std. error)**	**Coeff. HH partner (std. error)**
Constant	Constant	20.366 (0.740) ***	20.914 (0.787) ***	21.928 (0.749) ***	16.127 (0.855) ***
	X person variable		-1.122 (0.569) **	-5.991 (0.630) ***	5.927 (0.617) ***
Scenery	L1 Neighbourhood without green	-1.156 (0.673) *	0.102 (-1.089)	0.119 (-1.077)	0.221 (-1.077)
	X person variable		-1.868 (-1.292)	-1.909 (-1.278)	-1.993 (-1.278)
	L2 Green	4.218 (0.708) ***	2.810 (-1.136) **	2.825 (-1.124) **	2.859 (-1.123) **
	X person variable		2.196 (-1.372)	2.115 (-1.357)	1.989 (-1.357)
Pathway type	L1 Asphalt	1.962 (0.581) ***	1.956 (0.902) **	2.131 (0.893) **	2.109 (0.892) *
	X person variable		0.052 (-1.052)	-0.248 (-1.040)	-0.241 (-1.040)
Pathway width	L1 Wide	0.898 (0.624)	0.620 (0.952)	0.756 (0.942)	0.669 (0.942)
	X person variable		0.379 (-1.115)	0.379 (-1.103)	0.445 (-1.102)
Bench on route	L1 Yes	0.891 (0.612)	1.582 (0.921) *	1.684 (0.912) *	1.646 (0.911) *
	X person variable		-1.127 (-1.057)	-1.106 (-1.046)	-1.059 (-1.046)
# respondents		100%	48%	28%	71%
ρ^2		0.019	0.025	0.043	0.022

*Significance: *p<0.1; **p<0.05; ***p<0.01*

Table 19_ Cross effects mobility restrictions

		Coeff. base OLS (std. Error)	**Coeff. Walking stick (std. error)**	**Coeff. Effort dwelling some (std. error)**	**Coeff. Max walk 15 min. (std. error)**
Constant	Constant	20.366 (0.740) ***	21.128 (0.737) ***	21.127 (0.739) ***	24.129 (0.696) ***
	X person variable		-10.339 (-1.149) ***	-8.032 (0.956) ***	-16.716 (0.624) ***
Scenery	L1 Neighbourhood without green	-1.156 (0.673) *	0.311 (-1.078)	0.060 (-1.080)	-0.367 (-1.004)
	X person variable		-2.036 (-1.280)	-1.677 (-1.282)	-1.306 (-1.192)
	L2 Green	4.218 (0.708) ***	2.681 (-1.125) **	2.688 (-1.126) **	2.738 (-1.047) ***
	X person variable		2.287 (-1.359) *	2.329 (-1.361) *	1.976 (-1.265)
Pathway type	L1 Asphalt	1.962 (0.581) ***	2.096 (0.894) **	2.248 (0.895) **	2.170 (0.832) ***
	X person variable		-0.073 (-1.041)	-0.306 (-1.043)	-0.284 (0.970)
Pathway width	L1 Wide	0.898 (0.624)	0.447 (0.943)	0.628 (0.944)	0.560 (0.878)
	X person variable		0.377 (-1.104)	0.212 (-1.105)	0.488 (-1.028)
Bench on route	L1 Yes	0.891 (0.612)	1.482 (0.913)	1.601 (0.914) *	1.345 (0.850)
	X person variable		-1.181 (-1.047)	-1.125 (-1.048)	-0.272 (0.975)
# respondents		100%	7%	10%	16%
ρ^2		0.019	0.051	0.168	0.139

*Significance: *p<0.1; **p<0.05; ***p<0.01*

Table 20_ Cross effects social restrictions

		Coeff. base OLS (std. Error)	Coeff. Low life satisfaction (std. error)	Coeff. Social average (Likert scale) (std. error)
Constant	Constant	20.366 (0.740) ***	21.191 (0.742) ***	30.144 (-1.062) ***
	X person variable		-6.663 (0.858) ***	-4.909 (0.390) ***
Scenery	L1 Neighbourhood without green	-1.156 (0.673) *	0.236 (-1.081)	0.058 (-1.068)
	X person variable		-1.980 (-1.283)	-1.745 (-1.268)
	L2 Green	4.218 (0.708) ***	2.840 (-1.128) **	2.723 (-1.115) **
	X person variable		2.076 (-1.362)	2.068 (-1.346)
Pathway type	L1 Asphalt	1.962 (0.581) ***	1.999 (0.896) **	1.930 (0.885) **
	X person variable		0.117 (-1.044)	-0.119 (-1.032)
Pathway width	L1 Wide	0.898 (0.624)	0.506 (0.946)	0.531 (0.934)
	X person variable		0.405 (-1.107)	0.454 (-1.094)
Bench on route	L1 Yes	0.891 (0.612)	1.464 (0.915)	1.483 (0.904)
	X person variable		-0.979 (-1.050)	-0.976 (-1.037)
# respondents		100%	11%	100%
ρ^2		0.019	0.061	0.027

*Significance: *p<0.1; **p<0.05; ***p<0.01*

7.2.3 Social restrictions

Finally, the same variables as the MNL model are run here again to see what cross effects can be found in the OLS for elderly with any kind of social restriction. Appendix E.3 includes the full overview of the OLS cross effect results for elderly with a social restriction, and table 20 shows the most interesting results for the variables of elderly that have indicated to have a life satisfaction of 6 or lower, and the average of all social indicators. It was expected that the green restorative attribute has a positive cross effect. Table 20 (page 65) however, does not show a statistical significant cross effect for green, and thus nothing can be said about this statement. Most cross effects are not statistically significant in the OLS for the physical or social attributes though. As explained before, this group of elderly was relatively small, and not much can be concluded. However, the average walking time can again be retrieved from the constant, and it shows that with each increasing life satisfaction point, the willingness to walk also increases with 3 minutes. Furthermore, with increasing point for the average social indicator, elderly are willing to walk 5 minutes less. So, when elderly have low values for social indicators and feel lonely or have a small social network, they are less willing to walk, as expected.

7.3 COMPARISON MNL AND OLS RESULTS

The results of this stated choice experiment indicate that the Dutch elderly population prefers the social value of a green environment over the physical attributes of accessibility on the daily walking route towards the supermarket. The results of the MNL model show that the restorative attribute is even more important than distance. Within the physical attributes, the pathway type of asphalt is the most preferred, followed by a wide pathway, and lastly benches on the route. The MNL results can however not be conclusive on the whole restorative attribute, since the level of neighbourhood without green is not statistically significant. Running a regular OLS however, shows that the attribute of green is very important. Elderly are willing to walk less time through a neighbourhood without green, and they are willing to walk extra time when the route goes through a green area.

These results are very general though, and the group of elderly cannot be seen as a homogenous group of people. The latent class model identified heterogeneity and classified one class of elderly that rather order their groceries online or walk short distance as opposed to the class of elderly that is willing to walk further in an optimized environment.

The cross effects of different variables show that people with any type of mobility restriction are willing to walk relative short distances compared to the whole group of elderly. The optimization of physical attributes could increase the willingness to walk though, especially with the addition of benches. For those people with self-stated low life satisfaction or smaller social network (and loneliness) are more inclined to order online. However, more research is needed to find out what the effect of a restorative environment is for this specific group of people.

8. Application

With the results from the MNL model, an application tool can be developed to help evaluate and optimize current public space design. This chapter will show the toolbox that is created with the results from the MNL, and then shows how this tool can be used to evaluate existing daily walking routes of elderly, complementary to existing research on the evaluation of walking routes for the elderly population.

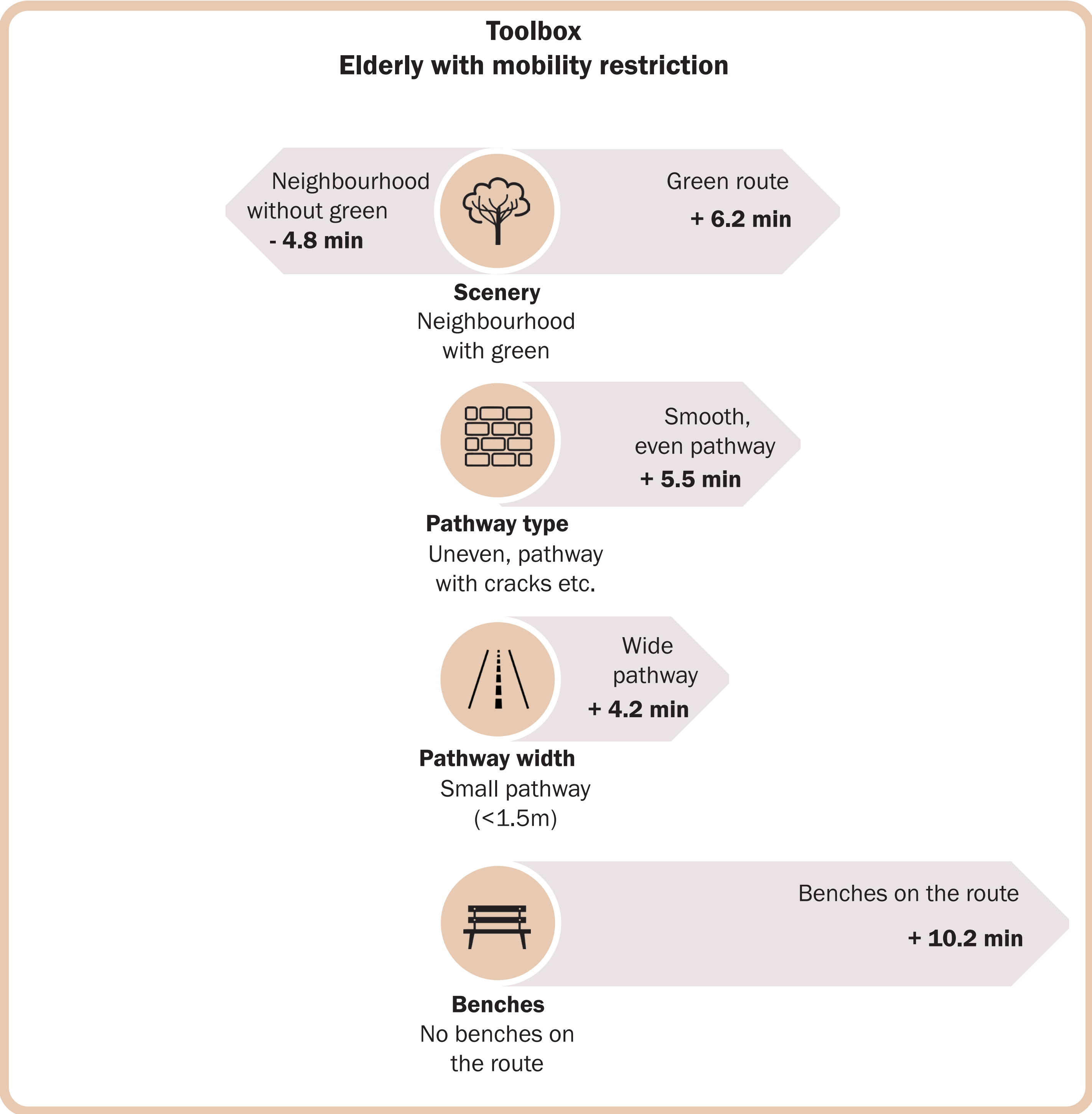
Other researches have also investigated the preferences of elderly in their living environment. Ontwerp & Overheid (2020) for example have researched upon the preferences of seniors in their own home. They have created a toolbox that can be used to optimize senior homes, shown in figure 26.

Figure 26_ Example toolbox senior living (Ontwerp & Overheid, 2020)

	Size dwelling	Balcony /garden	Openness dwelling	Size building	Parking	Entrance	Common garden	Common space	Location
higher value/ utility	110 m2 (+16% value)	Ground floor, garden 12m2 (+13% value)	Open kitchen, no doorway living-sleeping	< 20 dwellings (+22% value)	Indoor parking garage (+14% value)	Large hall/atrium with lift	Yes, private, residents only	Yes, a small cafetaria or a supermarket	Suburbs of a larger city (+5% value)
reference dwelling	90 m2	No ground floor, balkony 12m2	Closed kitchen, no doorway living-sleeping	20-80 dwellings	Outdoor parking reserved for residents	Small hall with a lift	Yes, public garden	Yes, a recreation area/ a meeting place	Small city, more than 15 min driving to larger city
lower value/ utility	70 m2 (-34% value)	No ground floor, balkony 5m2 (-24% value)	Open kitchen, doorway living-sleeping	> 80 dwellings (-28% value)	Public parking on the street (-29% value)	Outdoor gallery (-16% value)	NO (-16% value)	NO (-13% value)	Larger city (-15% value)

This research is an extend to the one shown above, as it looks at the preferences of the elderly in public space as opposed to their private homes. A similar toolbox can therefore be created, shown in figure 27. Note that the toolbox is created for the specific target group of elderly with some mobility restriction that cannot walk further than 15 minutes without having to take a break. Chapter 6.3 and 7.2 have shown the importance of this heterogeneity and these elderly with a mobility restriction have shown to have lower willingness to walk and the attribute differences are more important to them. Especially when wanting to stimulate daily outside activity, these elderly should be targeted with their specific needs. The toolbox can be used to optimize existing routes. This can be done looking at the routes that elderly in a nursing homes take towards the supermarket. These elderly usually have some type of mobility restriction and might have trouble walking this route.

Figure 27_ Toolbox for elderly with mobility restriction



Evaluating the route from nursing homes to the supermarket is exactly what Ossokina & Jürgenhake (2021) have done in their research on 'Inlcusive public spaces for happy senior living'. Using this tool public spaces were evaluated on elderly friendliness, taking into account the needs and preferences of the elderly target group. For six neighbourhoods the routes from nursing homes to the supermarket were evaluated on several attributes. Figure 28 shows their evaluation of the attributes, which includes 'even surface', 'Broad pathway', 'Pleasant surroundings (green)', and 'Benches every 200m'. These are the attributes that could be translated into the attributes researched upon in the current report. Using the method for rating attributes in the current research, the evaluation and optimization of routes can be quantified.

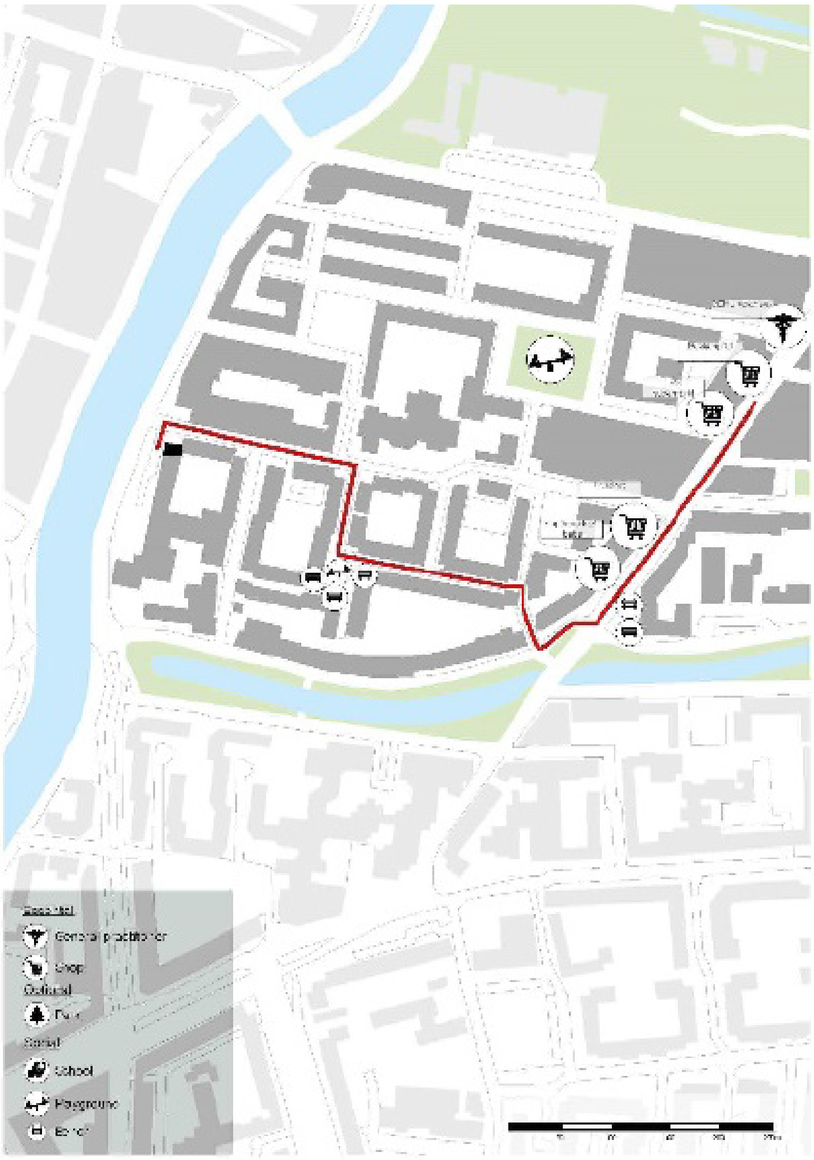
Figure 28_ Evaluation daily walking routes (Ossokina & Jürgenhake, 2021)

	Beverwaard	Feyenoord	Crooswijk	Charlois	Bospolder	Carnisse
Walkability, accessibility and traffic safety						
Free of obstacles	Tramrails hinder entering the park	Tree routes on several sidewalks	Some articulations in residential streets	Tree routes on several sidewalks	Cars parked half on the sidewalk	Lots of trash, hindering passage
Even surface	Concrete tiles	Tree routes on sidewalks	Concrete tiles	Tree routes on sidewalks	Concrete tiles	Concrete tiles
Broad pathway	Minimal 2 m	Minimal 2 m	Minimal 2 m	Not always	Minimal 2 m	Minimal 2 m
Safe crossings	Good view	Parking cars bloc view	Parking cars bloc view	Good view	Sometimes parking cars	Good view
Clear distinction from traffic	Yes	Pedestrian/ cycle mixed	Pedestrian/i cycle mixed	yes	yes	yes
Benches every 200 meter	Yes	Only benches in the park	No	yes	Only benches in Park 1943	yes
Benches nearby destination	One side of shopping street	No benches near shops	Yes, near shops	No benches near shops	No benches near shops	No benches near shops
Ease of access (of the seatings)	Benches in the park not accessible for a walker	yes	Benches not always easy to reach	Benches not always easy to reach See Fig 5	yes	yes

	Beverwaard	Feyenoord	Crooswijk	Charlois	Bospolder	Carnisse
Meaningfulness and socio-emotional aspects						
Pleasant surroundings on the way (green)	Park next to daily route	Park next to daily route	No park, but green streets.	Greenery and water next to daily route	Park 1943 next to the marketplace	No park but a green plaza
There is a place of encounter, with seating	Outside space in front of shops	No See Fig. 8, 9 and 10	Few benches at shopping street See Fig. 11	No benches at destination, see Fig. 12	Benches in front of elderly home, benches on the side of the Market-place (Park1943)	At the Amelandse plein a small grocery shops, opposite is the Amelandse park with benches
Place of encounter of sufficient size	Modest	Small	Small	Small	Large	Modest
Seating composition contributes to encounter	Round bench	n.a.	Next to each other	n.a.	Different compositions , see figures in appendix	Next to each other
Pleasant surroundings/activity at destination	park walking people	n.a.	Traffic	n.a.	Walking people Playing kids greenery	Walking people Playing kids greenery

We will use one of the evaluated routes from the research of Ossokina & Jurgenhake (2021) to show how the toolbox in this report could be used to optimize existing public spaces. The reference route can be found in Crooswijk, Rotterdam, shown in figure 29. It exists of a route to the supermarket through a neighbourhood with some green, the pathway is rated as good, with a wide pathway and no benches. Figure 30 shows what this route looks like in terms of the visualizations used in this report.

Figure 29_ Current walking routes elderly in Crooswijk, Rotterdam



Source: Ossokina & Jürgenhake (2021)

Figure 30 _ Visualization reference route Crooswijk

Using equation 3, the probability can be calculated that elderly with a mobility restriction are taking this route. The reference route has a probability of 53%, which means that a little over half of the elderly with a mobility restriction will probably take this route with these specific attributes. This however also means that 47% is more likely to stay home and order their groceries online. In order to stimulate daily outside activity, that last group of 47% should be reduced. The toolbox from figure 27 can be used to determine how the route can be optimized.

The toolbox shows that benches are likely to have the biggest impact on this route, as elderly with a mobility restriction are willing to walk 10 minutes extra if the route contains benches. Figure 31 shows what this route looks like, and the probability of equation 3 suggests that now 73% of these elderly are likely to take this route, as opposed to the 27% that rather stays home and prefers to order their groceries online.

Figure 31 _ Visualization Crooswijk with benches added

However, the toolbox also shows what happens if the pathway for example deteriorates over time due to bad maintenance, shown in figure 32. The probability predicts that only 41% of elderly will choose this route is the pathway gets worse over time. This shows how important it is to keep the pathway in good condition.

Figure 32 _ Visualization Crooswijk with dilapidated pathway type

Finally, one might also wonder what happens if the situation gets optimized completely by adding benches ánd add green to the route, as shown in figure 33. The probability increases to 82%. This also means that 18% of elderly with a mobility restriction will still rather stay home and order their groceries online in a completely optimized environment. This suggests that there is a limit to the optimization of public spaces for the elderly to stimulate daily outside activity. 18% is simply not willing or not able to do their groceries physically.

Figure 33 _ Visualization Crooswijk with benches ánd green route

So, with the help of the toolbox can be determined where investments are attractive and where deterioration should be avoided in order to stimulate more daily outside activity of the elderly population. Existing routes can be optimized with the use of the toolbox and the calculation of the probability. Developers, designers, and investors can use this information to create more optimized outdoor spaces.

9. Conclusion and discussion

9.1 CONCLUSION

The current report investigated how public space design can be optimized to stimulate daily outside activity of the elderly population. Because of their reduced functional capacity caused by the ageing process and reduced social network that can lead to lower life satisfaction, elderly have different needs and preferences. Not only does a public space needs to be accessible for everyone, it should also offer restoration that impacts mental wellbeing.

First a literature review was conducted to find the most important physical and social (restorative) attributes within the public space for elderly on their daily walking route to the supermarket. A stated choice experiment was executed to investigate the preferences of elderly and their willingness to walk. For the whole group of elderly, a green route is the most important, followed by the physical attributes of pathway type, pathway width, and the presence of a bench on the route. Hypothesis 1 stated that: *"In general, elderly will prefer a green restorative scenery over physical attributes. Within the physical attributes, pavement type is expected to be most important, followed by pavement width, and finally bench on route".* The results of this research are indeed in line with this hypothesis. Furthermore, the cross effects for several variables were tested to establish heterogeneity. First of all, for the elderly with an age of 75 and over, there were found no statistical differences, meaning that the order of importance remains the same as the whole group of elderly. Hypothesis 2, stating that: *"the oldest group of elderly (age 75+) are expected to value some physical attributes over the social attributes, as elderly get more mobility restrictions when growing older",* can thus not be supported. For the group of elderly with any type of mobility restrictions, we found some statistical significant differences. Generally, this group is more inclined to order their groceries online. When looking at hypothesis 3, *"elderly that have some type of mobility restriction are expected to value physical attributes over social attributes"*, the order of importance changes a little bit, since neighbourhood without green becomes less important and the presence of a bench becomes more important. Hypothesis 3 however cannot be supported, since not all physical attributes become more important than the social restorative attribute for elderly with a mobility restriction. However, the general assumption that elderly with a mobility restriction value some physical attributes over the social attributes seems correct. The results indicate that restoration still plays an important role for these people. When focusing on the results of the regular OLS, the green restorative attribute increases even. Finally, hypothesis 4: *"elderly that have some kind of reduced mental wellbeing are expected to value the social attribute of green scenery over the physical attribute",* can also not be accepted. For elderly with some reduction of mental wellbeing, the results were mostly not statistical significant, despite the fact that this group of elderly is more inclined to order their groceries online. So, additional research is needed to investigate this relationship.

The main research question of this report was: *How can the design of existing public spaces be improved to stimulate daily outside activity of elderly, based on the preferences of the physical and social needs of the seniors?*

In general, Dutch elderly can be stimulated to increase their daily outside activity by improving the restoration of the environment, as this is shown to be the most important attribute. Elderly are willing to walk an extra 10 minutes if they can walk through a green scenery. The physical attributes should however not be ignored, as a public space should remain accessible, mainly with a correct pathway type.

However, the results of this report also showed that the heterogeneity within the elderly target group of elderly plays an important role in the optimization of public space. Different physical or social needs result in different preferences of the public space. Current routes can be evaluated with the use of a toolbox based on the MNL results. This was done specifically for those elderly that were not able to walk more than 15 minutes without having to take a break. This toolbox shows for specific routes how attribute changes influences the willingness to walk of those elderly with mobility restrictions. Routes can therefore be optimized to stimulate daily outside activity of the elderly population.

9.2 FUTURE RESEARCH AND LIMITATIONS

Besides the limitations mentioned throughout the report, such as the disadvantages of using visualizations, and the limitations that come with the stated choice experiment in general, there are some additional limitations to this research. First of all, the research is limited to only one restorative attribute and 3 physical (accessible) attributes. As explained before, these are the most important attributes for the elderly population in terms of accessibility and mental well-being in public space design. However, it would be very interesting to expand the attributes and see how they affect each other. This would very likely increase the current R square that is low. Initially the research also included attributes of the public space at the supermarket itself. Even though it was not executed, this public space would have given extra insight, as this is usually seen as a combination of a social and functional place, meaning that the social attributes might be even more important here than the accessibility. Furthermore, all attributes mentioned in table 1 and 2 are important for elderly. It would for example be very interesting to see how important physical comfortable attributes are to elderly. Especially in relation to the physical accessible attributes, but also in relation to restorative attributes as they might elevate the importance of one another. Street crossings (safety), visibility (perceived safety and control), or atmosphere are three physical comfortable attributes that might play a role in restoration as well, as they could reduce stress. One might say that adding these attributes also blurs the line between physical versus restorative value of public space a little, which in itself is very fascinating as well.

In literature research, entropy and scenery show to have an effect on the restorative value of a public space. Therefore, another future perspective would be to explore the influence of restoration in more details. Besides these known topics for restoration within the built environment, it would also be fascinating to investigate other social design elements that might affect the restorative value, focussing on flow of other people (mentioned a few times in literature), but also street art, or even music, a these elements generally could meet all requirements of becoming a restorative environment.

Finally, the latent class model and cross effect models show the high heterogeneity within the group of elderly. The distinction between elderly with mobility restrictions, elderly with reduced mental well-being, or elderly with a combination of both have shown to be very important in terms of their preferences and needs. To better understand the importance of social versus physical attributes for the specific groups of elderly, such as the group of elderly with reduced mental wellbeing or elderly with mobility restrictions, more research is needed on this topic.

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Appendices

APPENDIX A CONSULT PROFESSIONALS ATTRIBUTES

The consults were done with the following professionals (no specific order):

- Jolanda Manders, location coordinator of the organization ‘Zorgboog’. Jolanda works on the location Sint Jozefheil in Bakel, where mostly elderly live that relatively need much care and are less independent.
- Ad Janssen, location coordinator of the organization ‘Zorgboog’. Ad works on the location de Wilbertdries in Bakel. This is location that mostly houses people in need of minimal care and live independently.
- Will Tielemans is a project developer of the organization ‘Zorgboog’. Will helps (re) development of nursing homes, elderly homes, and other living concepts for elderly to improve healthy ageing.
- Laura Clement is a doctor specialized in elderly care. Laura mainly works at Zonnelied in Oss. This location houses elderly that can no longer execute most daily activities themselves, such as grocery shopping.
- Carl van Aalst is a manager at the supermarket of Albert Heijn de Bus, in Waalre.
- Wouter Griep is a manager at the supermarket of Albert Heijn Den Hof, in Waalre.

The conversations were held in Dutch, and to avoid misinterpretation, the transcripts are kept in Dutch as well. Part of the conversations that were not related to this research is not included.

APPENDIX B FRACTIONAL FACTORIAL DESIGN

Alternative	Profile	Scenery	Distance	Pathway type	Pathway width	Bench
1	00000	Neighbourhood	5 min	Tiles	Small	No bench
2	00110	Neighbourhood	5 min	Asphalt	Wide	No bench
3	00001	Neighbourhood	5 min	Tiles	Small	Bench
4	01011	Neighbourhood	15 min	Tiles	Wide	Bench
5	01100	Neighbourhood	15 min	Asphalt	Small	No bench
6	01101	Neighbourhood	15 min	Asphalt	Small	Bench
7	01010	Neighbourhood	15 min	Tiles	Wide	No bench
8	00101	Neighbourhood	5 min	Asphalt	Small	Bench
9	01110	Neighbourhood	15 min	Asphalt	Wide	No bench
10	10000	Neigh. with green	5 min	Tiles	Small	No bench
11	10110	Neigh. with green	5 min	Asphalt	Wide	No bench
12	10001	Neigh. with green	5 min	Tiles	Small	Bench
13	11011	Neigh. with green	15 min	Tiles	Wide	Bench
14	11100	Neigh. with green	15 min	Asphalt	Small	No bench
15	11101	Neigh. with green	15 min	Asphalt	Small	Bench
16	11010	Neigh. with green	15 min	Tiles	Wide	No bench
17	10101	Neigh. with green	5 min	Asphalt	Small	Bench
18	11110	Neigh. with green	15 min	Asphalt	Wide	No bench
19	20000	Green	5 min	Tiles	Small	No bench
20	20110	Green	5 min	Asphalt	Wide	No bench
21	20001	Green	5 min	Tiles	Small	Bench
22	21011	Green	15 min	Tiles	Wide	Bench
23	21100	Green	15 min	Asphalt	Small	No bench
24	21101	Green	15 min	Asphalt	Small	Bench
25	21010	Green	15 min	Tiles	Wide	No bench
26	20101	Green	5 min	Asphalt	Small	Bench
27	21110	Green	15 min	Asphalt	Wide	No bench

APPENDIX C CONSULT ELDERLY FOR VISUALIZATIONS

Table C.1_ preferences of images by elderly target group (best preferred to least preferred: green- yellow- orange)

Resp.	Age	Gender	A	B	C	Remarks
1	67	F			X	A: looks friendly and challenging B: looks more clear than A C: addition of colour is good, it makes the houses look more realistic.
2	69	M	X			B: very confusing C: image on the right is more clouded/darker/sadder. This could have a negative influence
3	70	F		X		A: too sketchy to understand the environment B: Enjoyable. Enough details to create the image, but also not too crowded. The buildings in the background are the same, scenery is therefore clear in its differences C: Can be too crowded quickly, good representation though.
4	74	F			X	
5	71	F			X	
6	68	F	X			
7	74	F			X	
8	68	F			X	
9	70	M	X			
10	69	F		X		
11	72	F	X			
12	75	F	X			

APPENDIX D QUESTIONNAIRE EXPERIMENT

Game of choice Walking route to the supermarket

Taking a daily walk is good for both body and mind. In this research from the universities of Eindhoven and Delft, we design daily walking routes for the people that might have trouble walking, like seniors. As a first step, we will investigate which elements of a walking route towards the supermarket are attractive or troublesome for seniors. Thank you for helping us with this!

In this choice game you will be asked to make a choice between two different walking routes for a total of 5 times. Besides that, some other questions will be asked about yourself. Your answers cannot be traced back to you. This means that the researchers do not know which data is yours.

Filling in the questionnaire will take about 15 minutes. Please take the time to read the explanations and questions thoroughly. If you have any questions, please email them to the researcher Pleun van Wijk, master student of the TU Eindhoven: p.v.wijk@student.tue.nl

Thank you in advance for participating!

Pleun van Wijk

*Before we start, we would like to determine whether you fall within the target group. Please answer the following three questions.

Are you aged 65 or more?

Choose one of the following answers

○ Yes ○ No

*How often have you WALKED somewhere in the past two weeks (for example walking the dog, doing groceries, visit other people, etc.)? (In a wheelchair also counts)

Choose one of the following answers

○ Not once ○ Once ○ Twice or more

*The questionnaire contains pictures. These are not shown properly on a telephone. In case you are logged in on a telephone, please switch to a computer or tablet (ipad).

On which devide are you participating?

Choose one of the following answers

○ Computer ○ Tablet or ipad ○ Telephone

Consent form

*Thank you, you fit in with the target group. To participate in this questionnaire, we need your consent. Please read the following statements and the toestemmingsformulier thoroughly. If you understand and agree with them, please give your consent. Please notice: if you do not consent, you will leave this questionnaire.

- I agree with participation of this research
- I read the consent form. I was able to ask question. I have had enough time to decide whether I wanted to participate.
- I know that participation is voluntary. I also know that I can decide to quit at any moment.
- I give permission to collect and use my data to answer the research question
- I give permission to storage of aggregated anonymized information from this research in data-archives, to be used for replication purposes and future research.

Choose one of the following answers

○ I agree

○ I do not agree

Some questions about yourself

We will now ask some questions about yourself.

*What is your age?

Choose one of the following answers

- 65 till 69 years old
- 70 till 74 years old
- 75 years old or more

*What is your gender?

Choose one of the following answers

- Male
- Female

*What is your zipcode? (4 digits and 2 letter without space, so for example 1234AB)

Please check the format of your answer.

*In general, how satisfied are you with your life? On a scale from 1 to 10, what would you rate it?

Choose one of the following answers

Please choose...

*Do you use any walking aids while walking outside?

Check all that apply

- Wheelchair
- Rollator
- Walking stick
- Walker
- Scooter
- No walking aid
- Other:

*How easy can you sit down or get up from a chair, couch or bench?

Choose one of the following answers

- Without effort
- Some effort
- Great effort
- Only with help from others

*How easy can you enter or leave your dwelling from the street?

Choose one of the following answers

- Without effort
- Some effort
- Great effort
- Only with help from others

*How long can you walk without having to take a break to rest?

Choose one of the following answers

- Maximum of 5 minutes
- Maximum of 15 minutes
- Maximum of 30 minutes
- Maximum of 45 minutes
- More than 45 minutes

*Please indicate how much you agree with the following statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
I regularly have contact with people OUTSIDE of my household (friends, family, colleagues)	○	○	○	○	○
I have enough people around me to turn to for help when needed.	○	○	○	○	○
I regularly feel lonely	○	○	○	○	○

Supermarket

The following questions are about the supermarket that you usually go to. If there are multiple supermarkets, choose the one that you visit most often.

*How do you usually do your grocery shopping?

Choose one of the following answers

- I go grocery shopping by myself
- I usually go grocery shopping with someone else (e.g. partner or family member)
- Someone else does the grocery shopping for me
- I order my groceries online and have them delivered at home

*How often do you WALK to the supermarket? (wheelchair/scooter do also count)

Choose one of the following answers

- Less than once a week
- 1 to 2 times a week
- 3 to 4 times a week
- 5 times a week or more

*How often do you WALK to an activity that is not the supermarket (for example to take a stroll, visit people, go to meetings, (voluntary) job, hobby, etc.)?

Choose one of the following answers

- Less than once a week
- 1 to 2 times a week
- 3 to 4 times a week
- 5 times a week or more

*With which purpose do you go to the supermarket?

Check all that apply

- To get groceries
- To stay active
- To see other people
- To have something to do
- Other:

*How long is the walk to the supermarket that you visit most often? (from your front door)

Choose one of the following answers

- Less than 5 minutes
- Between 5 and 15 minutes
- Between 15 and 30 minutes
- Longer than 30 minutes

*Are you satisfied with the current walking route towards the supermarket that you visit most often?

Choose one of the following answers

- Very satisfied
- satisfied
- Neutral
- Unsatisfied
- Very unsatisfied

Could you elaborate your answer? What makes that you are satisfied or unsatisfied?

*Are there any benches or resting areas present on the walking route towards the supermarket?

Choose one of the following answers

- Yes there at least 1 bench on the route
- No benches

*Are you satisfied about the public space near your supermarket? (This public space is about the street or square that the supermarket is located on)

Choose one of the following answers

- Very satisfied
- Satisfied
- Neutral
- Unsatisfied
- Very unsatisfied

Could you elaborate your answer? What makes that you are satisfied or unsatisfied?

Route towards the supermarket

Now the choice game begins. Imagine that you have to do some grocery shopping, but you do not have access to a car or bicycle. The weather is good, no wind or rain and the temperature is comfortable. You can therefore decide to walk to the supermarket.

Later you will get a choice between two possible walking routes five times. See the example below, you do NOT HAVE TO MAKE A CHOICE yet. For the tablet/Ipad users: please use your screen landscape mode.

Route 1

Route 2

The routes differ in quality and/or walking time. Neither of the routes is probably ideal, but we still want you to indicate which route you prefer. You can also choose neither of the routes, but have the groceries delivered for €2.50.

Each route consists of 5 characteristiccs that can vary in different combinations:

How long is the walk to the supermarkt (from the front door)? *5 minutes OR 15 minutes*

Does the route go through the neighbourhood or through green? *Neighbourhood without green OR Park*. There is also the possibility of a route through a green neighbourhood

How wide is the walking path? *Narrow* (Wide enough for a walker) OR *wide* (wide enough for two walkers)

What kind of walking path is there? *Tiles* OR *Asphalt*

Are there any benches to sit along the route? *No benches* OR *Benches on the route*

Please go to the next screen to start the game.

*Choice 1/5

Below are two routes to the supermarket. Would you please indicate which you prefer. You can also choose not to walk any of the routes and have groceries de-livered for €2.50.

Route 1

5 minuten

Voetpad asfalt | Breed | Geen bankjes

Route 2

5 minuten

Voetpad tegels | Smal | Bankjes op de route

Choose one of the following answers

- Route 1
- Route 2
- I stay home and have groceries delivered for €2.50

*Now imagine that you do not need any groceries.

Would you like to take a walk along Route 1? And if yes, how long?

Choose one of the following answers

Please choose...

***Would you like to take a walk along Route 2? And if yes, how long?**

Choose one of the following answers

Please choose...

To complete the questionnaire

Could you finally answer some additional questions?

*Which people are currently part of your household?

Check all that apply

- Myself
- Partner/ spouse
- Child(ren)
- Ohter family/Others
- I live in with someone else

*Do you live in a rental or owner-occupied home?

Choose one of the following answers

- ○ Rental house from an housing association
- ○ Rental house, not from an housing association
- ○ Owner-occupied home
- ○ Other

*What is your highest completed education?

Choose one of the following answers

- ○ Primary school
- ○ VMBO/MAVO
- ○ HAVO/VWO/MBO
- ○ HBO/WO bachelor
- ○ WO master or higher
- ○ Other

*Are you retired?

Choose one of the following answers

○ Yes ○ No

Thank you!

Thank you for your participation!

If you have any remarks or questions, you can leave them below.

APPENDIX E RESULTS CROSS EFFECTS MNL AND OLS

Appendix E.1 Cross effect results Socio-demographics

Table E.1 cross effects socio demographics MNL

	base MNL	Age 75	Gender female	Urban extreme	HH alone	HH Partner	HH child	Dwelling rentalHA	Education low	Retired
a_10 No green	-0.029	-0.037	-0.041	-0.074	-0.011	-0.040	-0.005	-0.030	-0.058	-0.177
	(0.074)	(0.103)	(0.093)	(0.085)	(0.086)	(0.140)	(0.076)	(0.094)	(0.092)	(0.302)
a_12 Green	0.526***	0.596***	0.375***	0.487***	0.552***	0.568***	0.513***	0.475***	0.640***	1.144***
	(0.083)	(0.116)	(0.103)	(0.095)	(0.098)	(0.155)	(0.085)	(0.106)	(0.102)	(0.345)
a_2 Distance	-0.499***	-0.649***	-0.487***	-0.422***	-0.427***	-0.646***	-0.492***	-0.493***	-0.543***	-0.998***
	(0.071)	(0.100)	(0.091)	(0.081)	(0.084)	(0.130)	(0.073)	(0.090)	(0.088)	(0.302)
a_3 Pathway type	0.471***	0.551***	0.293***	0.420***	0.421***	0.542***	0.474***	0.430***	0.438***	0.459
	(0.067)	(0.096)	(0.084)	(0.077)	(0.078)	(0.125)	(0.069)	(0.084)	(0.082)	(0.293)
a_4 Pathway width	0.356***	0.342***	0.465***	0.353***	0.407***	0.266*	0.342***	0.382***	0.397***	0.304
	(0.078)	(0.107)	(0.099)	(0.089)	(0.092)	(0.145)	(0.080)	(0.098)	(0.097)	(0.305)
a_5 Bench	0.307***	0.325***	0.333***	0.314***	0.381***	0.177	0.276***	0.277***	0.300***	0.597**
	(0.066)	(0.089)	(0.083)	(0.075)	(0.077)	(0.125)	(0.067)	(0.084)	(0.081)	(0.269)
not	-1.449***	-1.446***	-1.761***	-1.424***	-1.585***	-1.092***	-1.487***	-1.783***	-1.382***	-1.008**
	(0.120)	(0.165)	(0.162)	(0.138)	(0.147)	(0.205)	(0.123)	(0.163)	(0.145)	(0.438)
cross_a_10 No green		-0.016	0.021	0.171	-0.077	0.015	-0.378	0.002	0.087	0.152
		(0.149)	(0.155)	(0.176)	(0.170)	(0.165)	(0.350)	(0.154)	(0.157)	(0.312)
cross_a_12 Green		-0.139	0.386**	0.153	-0.104	-0.060	0.288	0.125	-0.357**	-0.661*
		(0.166)	(0.175)	(0.198)	(0.186)	(0.184)	(0.406)	(0.171)	(0.178)	(0.356)
Cross_a_2 Distance		0.306 **	-0.046	-0.308*	-0.241	0.214	-0.124	-0.031	0.127	0.535*
		(0.142)	(0.147)	(0.169)	(0.158)	(0.155)	(0.331)	(0.147)	(0.150)	(0.310)
cross_a_3 Pathway type		-0.152	0.482***	0.203	0.158	-0.109	0.046	0.122	0.098	0.013
		(0.134)	(0.141)	(0.159)	(0.152)	(0.148)	(0.314)	(0.140)	(0.143)	(0.301)
cross_a_4 Pathway width		0.031	-0.271*	0.024	-0.217	0.121	0.427	-0.077	-0.118	0.053
		(0.156)	(0.162)	(0.188)	(0.176)	(0.172)	(0.390)	(0.162)	(0.163)	(0.316)
cross_a_5 Bench		-0.033	-0.071	-0.032	-0.283*	0.182	0.713**	0.080	0.032	-0.315
		(0.133)	(0.138)	(0.158)	(0.151)	(0.148)	(0.349)	(0.136)	(0.140)	(0.277)
cross_not		0.004	0.757***	-0.089	0.370	-0.582**	0.860	0.762***	-0.196	-0.479
		(0.241)	(0.245)	(0.284)	(0.261)	(0.255)	(0.577)	(0.246)	(0.261)	(0.455)
R^2	0.022	0.025	0.022	0.043	0.043	0.022	0.024	0.026	0.022	0.039

Table E.2 cross effects socio demographics OLS

	base OLS	Age 75	Gender female	Urban extreme	HH alone	HH Partner	HH child	Rental HA	Education low	Retired
a_10 No green	-1.156*	0.102	0.246	0.157	0.119	0.221	0.161	0.201	0.176	0.152
	(0.673)	-1.089	-1.087	-1.089	-1.077	-1.077	-1.089	-1.088	-1.086	-1.089
a_12 Green	4.218***	2.810**	2.838**	2.812**	2.825**	2.859**	2.813**	2.798**	2.695**	2.812**
	(0.708)	-1.136	-1.134	-1.136	-1.124	-1.123	-1.136	-1.135	-1.134	-1.136
a_3 Pathway type	1.962***	1.956**	2.040**	2.002**	2.131**	2.109**	1.998**	2.052**	2.128**	1.997**
	(0.581)	(0.902)	(0.901)	(0.903)	(0.893)	(0.892)	(0.902)	(0.901)	(0.901)	(0.903)
a_4 Pathway width	0.898	0.620	0.661	0.633	0.756	0.669	0.622	0.587	0.721	0.628
	(0.624)	(0.952)	(0.951)	(0.953)	(0.942)	(0.942)	(0.953)	(0.951)	(0.950)	(0.952)
a_5 Bench	0.891	1.582*	1.575*	1.613*	1.684*	1.646*	1.614*	1.641*	1.618*	1.614*
	(0.612)	(0.921)	(0.920)	(0.922)	(0.912)	(0.911)	(0.922)	(0.921)	(0.920)	(0.922)
cross_a_10 No green		-1.868	-1.955	-1.935	-1.909	-1.993	-1.939	-1.953	-1.925	-1.931
		-1.292	-1.290	-1.292	-1.278	-1.278	-1.293	-1.291	-1.289	-1.293
cross_a_12 Green		2.196	2.162	2.176	2.115	1.989	2.174	2.181	2.251	2.178
		-1.372	-1.370	-1.372	-1.357	-1.357	-1.372	-1.370	-1.369	-1.372
cross_a_3 Pathway type		0.052	-0.006	-0.016	-0.248	-0.241	-0.011	-0.079	-0.037	-0.011
		-1.052	-1.050	-1.052	-1.040	-1.040	-1.052	-1.051	-1.049	-1.052
cross_a_4 Pathway width		0.379	0.295	0.336	0.379	0.445	0.352	0.309	0.233	0.339
		-1.115	-1.113	-1.115	-1.103	-1.102	-1.116	-1.114	-1.113	-1.115
cross_a_5 Bench		-1.127	-1.127	-1.153	-1.106	-1.059	-1.152	-1.204	-1.166	-1.155
		-1.057	-1.055	-1.057	-1.046	-1.046	-1.057	-1.056	-1.055	-1.057
Cross constant		-1.122**	-2.225***	-0.092	-5.991***	5.927***	-0.313	-1.871***	-2.606***	-0.075
		(0.569)	(0.583)	(0.664)	(0.630)	(0.617)	-1.257	(0.585)	(0.602)	-1.106
Constant	20.366***	20.914***	21.177***	20.400***	21.928***	16.127***	20.395***	21.099***	21.183***	20.451***
	(0.740)	(0.787)	(0.767)	(0.753)	(0.749)	(0.855)	(0.742)	(0.772)	(0.761)	-1.273
R^2	0.019	0.025	0.022	0.043	0.043	0.022	0.024	0.026	0.022	0.039

Appendix E.2 Cross effect results Mobility restrictions

Table E.3 cross effects mobility restrictions MNL

	base MNL	Rollator	Walking stick	walking aid	Effort sit some	Effort dwelling some	Max walk15	walking restrictions	Freq walk supermarket 0	Freq walk other 0
a_10 No green	-0.029	-0.044	0.008	-0.001	0.080	0.001	0.046	0.039	-0.042	0.017
	(0.074)	(0.077)	(0.077)	(0.080)	(0.088)	(0.078)	(0.083)	(0.087)	(0.093)	(0.087)
a_12 Green	0.526***	0.507***	0.539***	0.514***	0.518***	0.503***	0.550***	0.556***	0.593***	0.615***
	(0.083)	(0.087)	(0.086)	(0.089)	(0.098)	(0.088)	(0.094)	(0.098)	(0.104)	(0.099)
a_2 Distance	-0.499***	-0.550***	-0.463***	-0.512***	-0.493***	-0.543***	-0.420***	-0.464***	-0.386***	-0.403***
	(0.071)	(0.075)	(0.073)	(0.077)	(0.084)	(0.075)	(0.080)	(0.083)	(0.089)	(0.085)
a_3 Pathway type	0.471***	0.472***	0.455***	0.458***	0.399***	0.449***	0.430***	0.429***	0.434***	0.431***
	(0.067)	(0.070)	(0.069)	(0.071)	(0.079)	(0.070)	(0.075)	(0.078)	(0.084)	(0.078)
a_4 Pathway width	0.356***	0.374***	0.357***	0.368***	0.340***	0.355***	0.358***	0.381***	0.307***	0.359***
	(0.078)	(0.081)	(0.081)	(0.084)	(0.092)	(0.082)	(0.088)	(0.091)	(0.099)	(0.092)
a_5 Bench	0.307***	0.285***	0.296***	0.267***	0.211***	0.259***	0.210***	0.214***	0.228***	0.199**
	(0.066)	(0.068)	(0.068)	(0.070)	(0.077)	(0.069)	(0.074)	(0.077)	(0.083)	(0.078)
not	-1.449***	-1.676***	-1.536***	-1.770***	-2.070***	-1.779***	-2.171***	-2.317***	-2.226***	-1.872***
	(0.120)	(0.131)	(0.127)	(0.138)	(0.159)	(0.133)	(0.162)	(0.175)	(0.189)	(0.157)
crossa10 No green		0.219	-0.501	-0.199	-0.411**	-0.388	-0.409**	-0.273	0.041	-0.139
		(0.283)	(0.308)	(0.218)	(0.167)	(0.273)	(0.187)	(0.169)	(0.154)	(0.167)
cross_a_12 Green		0.172	-0.196	0.042	0.017	0.183	-0.089	-0.140	-0.210	-0.318*
		(0.305)	(0.346)	(0.244)	(0.185)	(0.287)	(0.202)	(0.187)	(0.174)	(0.186)
Cross_a2 Distance		0.553**	-0.681**	0.080	-0.032	0.439*	-0.350**	-0.112	-0.321**	-0.355**
		(0.254)	(0.331)	(0.209)	(0.159)	(0.253)	(0.177)	(0.162)	(0.149)	(0.158)
cross_a3 Pathway type		0.069	0.424	0.132	0.279*	0.343	0.187	0.159	0.099	0.200
		(0.261)	(0.323)	(0.208)	(0.151)	(0.245)	(0.168)	(0.154)	(0.140)	(0.154)
cross_a4 Pathway width		-0.114	-0.083	-0.112	0.047	0.066	-0.028	-0.111	0.125	0.009
		(0.310)	(0.324)	(0.235)	(0.175)	(0.285)	(0.194)	(0.177)	(0.163)	(0.175)
cross_a5 Bench		0.283	0.167	0.275	0.351**	0.640**	0.561***	0.381**	0.224	0.410***
		(0.266)	(0.284)	(0.204)	(0.150)	(0.252)	(0.167)	(0.152)	(0.137)	(0.149)
cross_not		1.789***	1.004**	1.619***	1.736***	2.558***	2.160***	2.077***	1.452***	1.152***
		(0.401)	(0.435)	(0.320)	(0.260)	(0.392)	(0.280)	(0.268)	(0.256)	(0.256)
R^2	0.022	0.041	0.051	0.068	0.038	0.168	0.139	0.064	0.097	0.036

Table E.4 cross effects mobility restrictions OLS

	base OLS	Rollator	Walking stick	walking aid	Effort sit some	Effort dwelling some	Max walk15	walking restrictions	Freq walk supermarket 0	Freq walk other 0
a_10 No green	-1.156*	0.151	0.311	0.312	0.266	0.060	-0.367	-0.120	-0.029	0.233
	(0.673)	-1.079	-1.078	-1.073	-1.063	-1.080	-1.004	-1.022	-1.065	-1.046
a_12 Green	4.218***	2.817**	2.681**	2.750**	2.908***	2.688**	2.738***	2.754***	2.702**	2.381**
	(0.708)	-1.126	-1.125	-1.119	-1.109	-1.126	-1.047	-1.066	-1.111	-1.092
a_3 Pathway type	1.962***	2.334***	2.096**	2.343***	2.271***	2.248**	2.170***	2.335***	1.731*	2.170**
	(0.581)	(0.895)	(0.894)	(0.889)	(0.881)	(0.895)	(0.832)	(0.847)	(0.883)	(0.867)
a_4 Pathway width	0.898	0.574	0.447	0.432	0.672	0.628	0.560	0.443	0.364	0.406
	(0.624)	(0.944)	(0.943)	(0.938)	(0.930)	(0.944)	(0.878)	(0.893)	(0.932)	(0.915)
a_5 Bench	0.891	1.616*	1.482	1.505*	1.346	1.601*	1.345	1.228	1.560*	1.681*
	(0.612)	(0.913)	(0.913)	(0.908)	(0.900)	(0.914)	(0.850)	(0.865)	(0.901)	(0.885)
cross_a_10 No green		-1.833	-2.036	-1.977	-2.037	-1.677	-1.306	-1.416	-1.574	-1.691
		-1.281	-1.280	-1.273	-1.261	-1.282	-1.192	-1.213	-1.264	-1.242
cross_a_12 Green		2.196	2.287*	2.220	1.785	2.329*	1.976	1.767	2.091	2.962**
		-1.360	-1.359	-1.351	-1.340	-1.361	-1.265	-1.287	-1.342	-1.319
crossa3 Pathway type		-0.265	-0.073	-0.187	-0.128	-0.306	-0.284	-0.204	0.177	-0.285
		-1.043	-1.041	-1.036	-1.027	-1.043	(0.970)	(0.987)	-1.029	-1.011
crossa4 Pathway width		0.342	0.377	0.409	-0.055	0.212	0.488	0.475	0.407	0.655
		-1.105	-1.104	-1.098	-1.089	-1.105	-1.028	-1.046	-1.090	-1.071
cross_a_5 Bench		-1.075	-1.181	-1.077	-0.875	-1.125	-0.272	-0.370	-0.937	-1.118
		-1.048	-1.047	-1.041	-1.032	-1.048	(0.975)	(0.992)	-1.034	-1.016
Cross_constant		-8.727***	-10.339***	-9.127***	-8.662***	-8.032***	-16.716***	-13.973***	-7.807***	-10.984***
		-1.017	-1.149	(0.812)	(0.610)	(0.956)	(0.624)	(0.593)	(0.574)	(0.597)
Constant	20.366***	20.983***	21.128***	21.561***	22.954***	21.127***	24.129***	24.215***	23.439***	23.501***
	(0.740)	(0.736)	(0.737)	(0.736)	(0.744)	(0.739)	(0.696)	(0.713)	(0.758)	(0.731)
R^2	0.019	0.041	0.051	0.068	0.038	0.168	0.139	0.064	0.097	0.036

Appendix E.3 Cross effect results social restrictions

Table E.5 cross effects social restrictions MNL

	base MNL	Satisfaction Life low	Satisfaction Life	social contact no	Social people no	Social Lonely yes	social average	Purpose stay active	Purpose see others	Purpose to do
a_10 No green	-0.029	0.013	-0.715	-0.008	-0.047	0.006	-0.027	-0.032	-0.005	-0.050
	(0.074)	(0.080)	(0.486)	(0.077)	(0.076)	(0.077)	(0.219)	(0.081)	(0.077)	(0.076)
a_12 Green	0.526***	0.529***	0.735	0.521***	0.510***	0.517***	0.317	0.474***	0.554***	0.522***
	(0.083)	(0.088)	(0.536)	(0.087)	(0.085)	(0.087)	(0.247)	(0.090)	(0.087)	(0.086)
A_2 Distanc	-0.499***	-0.460***	-1.835***	-0.498***	-0.482***	-0.488***	-0.030	-0.562***	-0.517***	-0.476***
	(0.071)	(0.076)	(0.453)	(0.074)	(0.073)	(0.074)	(0.210)	(0.077)	(0.074)	(0.073)
a_3 Pathway type	0.471***	0.469***	0.971**	0.499***	0.476***	0.475***	0.587***	0.492***	0.487***	0.456***
	(0.067)	(0.071)	(0.437)	(0.070)	(0.069)	(0.070)	(0.198)	(0.073)	(0.070)	(0.069)
a_4 Pathway width	0.356***	0.385***	0.142	0.389***	0.373***	0.387***	0.604***	0.355***	0.373***	0.347***
	(0.078)	(0.084)	(0.505)	(0.081)	(0.080)	(0.082)	(0.232)	(0.084)	(0.081)	(0.080)
a_5 Bench	0.307***	0.308***	0.248	0.336***	0.301***	0.320***	0.293	0.287***	0.300***	0.303***
	(0.066)	(0.071)	(0.423)	(0.069)	(0.067)	(0.069)	(0.194)	(0.071)	(0.069)	(0.068)
Not	-1.449***	-1.647***	0.830	-1.525***	-1.465***	-1.524***	-2.203***	-1.519***	-1.460***	-1.403***
	(0.120)	(0.135)	(0.695)	(0.129)	(0.124)	(0.128)	(0.360)	(0.131)	(0.125)	(0.123)
cross10 No green		-0.333	0.090	-0.174	0.437	-0.468	0.000	0.024	-0.252	0.339
		(0.226)	(0.063)	(0.279)	(0.360)	(0.286)	(0.106)	(0.208)	(0.281)	(0.324)
cross_a_12 Green		-0.060	-0.028	0.146	0.440	0.128	0.108	0.321	-0.359	0.095
		(0.261)	(0.070)	(0.317)	(0.410)	(0.298)	(0.119)	(0.234)	(0.308)	(0.343)
Crossa2 Distanc		-0.345	0.176***	-0.064	-0.287	-0.195	-0.242**	0.422**	0.239	-0.327
		(0.220)	(0.059)	(0.264)	(0.333)	(0.259)	(0.102)	(0.201)	(0.271)	(0.300)
crossa3 Pathway type		0.036	-0.066	-0.430*	-0.105	0.014	-0.060	-0.168	-0.179	0.231
		(0.209)	(0.057)	(0.253)	(0.312)	(0.249)	(0.095)	(0.186)	(0.253)	(0.292)
crossa4 Pathway width		-0.285	0.027	-0.419	-0.445	-0.367	-0.126	0.018	-0.188	0.053
		(0.236)	(0.066)	(0.294)	(0.397)	(0.283)	(0.113)	(0.224)	(0.298)	(0.333)
crossa5 Bench		0.005	0.008	-0.366	0.072	-0.171	0.004	0.155	0.111	0.066
		(0.202)	(0.055)	(0.249)	(0.324)	(0.244)	(0.094)	(0.190)	(0.247)	(0.283)
Cross not		1.056***	-0.311***	0.431	0.106	0.702*	0.348**	0.439	0.167	-0.889
		(0.322)	(0.093)	(0.396)	(0.540)	(0.403)	(0.165)	(0.331)	(0.460)	(0.603)
R^2	0.022	0.061	0.028	0.022	0.030	0.058	0.027	0.022	0.022	0.025

Table E.6 cross effects social restrictions OLS

	base OLS	Satisfaction Life low	Satisfaction Life	social contact no	Social people no	Social Lonely yes	social average	Purpose stay active	Purpose see others	Purpose to do
a_10 No green	-1.156*	0.236	0.324	0.189	0.144	0.167	0.058	-0.010	0.160	0.150
	(0.673)	-1.081	-1.067	-1.086	-1.089	-1.084	-1.068	-1.086	-1.089	-1.089
a_12 Green	4.218***	2.840**	2.734**	2.742**	2.810**	2.840**	2.723**	2.758**	2.826**	2.808**
	(0.708)	-1.128	-1.113	-1.133	-1.136	-1.131	-1.115	-1.133	-1.136	-1.137
a_3 Pathway type	1.962***	1.999**	2.006**	1.966**	2.017**	1.897**	1.930**	2.026**	1.965**	2.005**
	(0.581)	(0.896)	(0.884)	(0.900)	(0.902)	(0.898)	(0.885)	(0.900)	(0.903)	(0.904)
a_4 Pathway width	0.898	0.506	0.418	0.591	0.633	0.523	0.531	0.611	0.658	0.635
	(0.624)	(0.946)	(0.933)	(0.949)	(0.952)	(0.948)	(0.934)	(0.950)	(0.953)	(0.954)
a_5 Bench	0.891	1.464	1.310	1.604*	1.642*	1.450	1.483	1.491	1.589*	1.619*
	(0.612)	(0.915)	(0.903)	(0.919)	(0.921)	(0.918)	(0.904)	(0.919)	(0.922)	(0.922)
cross_a_10 No green		-1.980	-2.057	-1.883	-1.901	-1.969	-1.745	-1.796	-1.930	-1.928
		-1.283	-1.266	-1.288	-1.292	-1.287	-1.268	-1.289	-1.292	-1.293
cross_a_12 Green		2.076	2.164	2.179	2.169	2.119	2.068	2.271*	2.199	2.182
		-1.362	-1.344	-1.368	-1.372	-1.366	-1.346	-1.368	-1.372	-1.373
cross_a_3 Pathway type		0.117	0.157	-0.119	-0.052	0.102	-0.119	0.015	0.037	-0.021
		-1.044	-1.030	-1.049	-1.052	-1.047	-1.032	-1.049	-1.052	-1.053
cross_a_4 Pathway width		0.405	0.483	0.414	0.355	0.484	0.454	0.430	0.323	0.330
		-1.107	-1.092	-1.111	-1.114	-1.110	-1.094	-1.112	-1.115	-1.117
cross_a_5 Bench		-0.979	-0.812	-1.120	-1.149	-0.902	-0.976	-0.970	-1.142	-1.160
		-1.050	-1.036	-1.054	-1.057	-1.053	-1.037	-1.055	-1.057	-1.058
Cross constant		-6.663***	2.951***	-5.275***	-2.244*	-6.134***	-4.909***	3.829***	1.249	-0.142
		(0.858)	(0.226)	-1.037	-1.283	-1.009	(0.390)	(0.785)	-1.057	-1.148
Constant	20.366***	21.191***	-1.890	20.849***	20.477***	20.931***	30.144***	19.772***	20.272***	20.389***
	(0.740)	(0.742)	-1.856	(0.743)	(0.741)	(0.742)	-1.062	(0.748)	(0.745)	(0.743)
R^2	0.019	0.061	0.028	0.022	0.030	0.058	0.027	0.022	0.022	0.025

Appendix E.4 Cross effect results supermarket

Table E.7 cross effects supermarket MNL

	base MNL	Distance supermarket walk long	Satisaction route supermarket low	Satisaction route supermarket neutral	Benches route no
a_10 No green	-0.029	-0.090	-0.009	-0.000	0.129
	(0.074)	(0.084)	(0.076)	(0.081)	(0.130)
a_12 Green	0.526***	0.449***	0.531***	0.540***	0.582***
	(0.083)	(0.093)	(0.085)	(0.090)	(0.144)
a_2 Distance	-0.499***	-0.560***	-0.490***	-0.410***	-0.587***
	(0.071)	(0.083)	(0.073)	(0.077)	(0.122)
a_3 Pathway type	0.471***	0.516***	0.480***	0.416***	0.649***
	(0.067)	(0.075)	(0.069)	(0.072)	(0.117)
a_4 Pathway width	0.356***	0.443***	0.368***	0.280***	0.380***
	(0.078)	(0.090)	(0.080)	(0.085)	(0.133)
a_5 Bench	0.307***	0.293***	0.291***	0.239***	0.356***
	(0.066)	(0.075)	(0.067)	(0.072)	(0.115)
not	-1.449***	-1.586***	-1.644***	-1.797***	-1.345***
	(0.120)	(0.142)	(0.129)	(0.140)	(0.204)
cross_a_10 No green		0.283	-0.450	-0.216	-0.230
		(0.180)	(0.381)	(0.208)	(0.158)
cross_a_12 Green		0.403*	0.031	-0.160	-0.086
		(0.209)	(0.397)	(0.232)	(0.176)
Cross_a_2 Distance		0.237	-0.255	-0.572***	0.141
		(0.164)	(0.346)	(0.202)	(0.150)
cross_a_3 Pathway type		-0.200	-0.238	0.399**	-0.267*
		(0.168)	(0.332)	(0.194)	(0.143)
cross_a_4 Pathway width		-0.376**	-0.297	0.498**	-0.035
		(0.184)	(0.386)	(0.219)	(0.164)
cross_a_5 Bench		0.089	0.481	0.417**	-0.065
		(0.160)	(0.340)	(0.182)	(0.141)
cross_not		0.482*	2.064***	1.584***	-0.160
		(0.274)	(0.479)	(0.306)	(0.253)
R^2	0.022	0.026	0.027	0.022	

Table E.8 cross effects supermarket OLS

	base OLS	Distance supermarket walk long	Satisaction route supermarket low	Satisaction route supermarket neutral	Benches route no
a_10 No green	-1.156*	0.067	0.147	0.024	-0.001
	(0.673)	-1.087	-1.086	-1.086	-1.152
a_12 Green	4.218***	2.858**	2.755**	2.713**	2.661**
	(0.708)	-1.134	-1.134	-1.133	-1.193
a_3 Pathway type	1.962***	1.936**	2.041**	1.939**	1.826*
	(0.581)	(0.901)	(0.900)	(0.900)	(0.994)
a_4 Pathway width	0.898	0.620	0.617	0.508	0.442
	(0.624)	(0.951)	(0.950)	(0.950)	-1.053
a_5 Bench	0.891	1.591*	1.557*	1.529*	1.410
	(0.612)	(0.920)	(0.920)	(0.919)	-1.044
cross_a_10 No green		-1.839	-1.881	-1.885	-1.689
		-1.290	-1.289	-1.289	-1.420
cross_a_12 Green		2.136	2.271*	2.211	2.409
		-1.370	-1.369	-1.368	-1.482
cross_a_3 Pathway type		-0.000	-0.133	0.086	0.247
		-1.050	-1.050	-1.049	-1.225
cross_a_4 Pathway width		0.322	0.368	0.482	0.622
		-1.113	-1.112	-1.112	-1.307
cross_a_5 Bench		-1.146	-1.092	-1.016	-0.849
		-1.055	-1.055	-1.055	-1.289
Cross constant		2.687***	-5.717***	-3.536***	-0.646
		(0.682)	-1.310	(0.756)	-1.558
Constant	20.366***	19.836***	20.674***	21.040***	20.805***
	(0.740)	(0.751)	(0.741)	(0.751)	-1.262
R^2	0.022	0.026	0.027	0.022	