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Bergefurt, A.G.M.

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A.G.M. Bergefurt (0902306)
Urban Systems & Real Estate
Eindhoven University of Technology
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Colophon

Author: A.G.M. (Lisanne) Bergefurt
Student ID: 0902306
E-mail: Lisanne.bergefurt@gmail.com

Organisation: Eindhoven University of Technology
Faculty of Architecture, Building & Planning
Chair of Urban Systems & Real Estate

Supervisor 1: dr. ir. A.D.A.M. (Astrid) Kemperman
Supervisor 2: dr. ir. P.E.W. (Pauline) van den Berg
Supervisor 3: ir. A.W.J. (Aloys) Borgers
Supervisor 4: dr. ing. P.J.H.J. (Peter) van der Waerden

Advisor: ir. M. (Marco) Hommel
Advisor: ir. G. (Gert) Oosterhuis

Date: November 29, 2019
Place: Eindhoven

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Preface

This master thesis is written in the context of completing my Master Urban Systems & Real Estate at the Eindhoven University of Technology. The topic of my thesis, the investigation of the relationships between public space use and loneliness and life satisfaction is interesting to me, since the number of public spaces, especially in urban settings, is decreasing. In urban areas, such as 's-Hertogenbosch, the availability of public spaces can contribute to people feeling socially engaged and to healthy ageing in place among ageing residents. Using public space can thus increase people's satisfaction with their life and reduce their feelings of loneliness.

Firstly, I would like to thank my supervisors Astrid Kemperman and Pauline van den Berg for providing guidance and feedback during my research process. I would also like to thank my supervisors Aloys Borgers and Peters van der Waerden for their overall support and feedback to further improve my thesis. Furthermore, I would like to say thank you to Marco Hommel and Gert Oosterhuis for providing me with the opportunity to take a gander into the advisory world of management and development of public spaces in various municipalities in the Netherlands. Finally, I would like to thank all my family and friends for supporting me during my research process.

Lisanne Bergefurt

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Article

Bergefurt, L., Kemperman, A., van den Berg, P., Borgers, A., van der Waerden, P., Oosterhuis, G., & Hommel, M. (2019). Loneliness and Life Satisfaction Explained by Public-Space Use and Mobility Patterns. International Journal of Environmental Research and Public Health, 16(4282), 1-20.

An article is written for the special issue of the International Journal of Environmental Research and Public Health: “Daily Travel and Wellbeing among the Elderly". The article is added to Appendix A.

Summary

Abstract

Previous research has shown that personal and neighbourhood characteristics could influence life satisfaction and loneliness of people and that exposure to public space may also affect the extent to which residents feel lonely or satisfied. However, previous research only focused on one of these relationships, instead of on the simultaneous effect of both personal and neighbourhood characteristics on public space use, loneliness and life satisfaction. This study, therefore, aims to gain insights into how public space use mediates the effects between personal and neighbourhood characteristics on the one hand and loneliness and life satisfaction on the other hand. A path analysis approach is used to study the relationships, based on a sample of 200 residents of three neighbourhoods of the city ‘s-Hertogenbosch, the Netherlands. The results show that the effect of public space use on loneliness and life satisfaction is limited. However, strong relationships can be found between various personal and neighbourhood characteristics on loneliness and life satisfaction and on public space use. Loneliness was also found to significantly affect life satisfaction. Policymakers should, therefore, mainly focus on developing highly walkable and socially cohesive neighbourhoods, where green spaces are present and accessible for all residents of a neighbourhood.

Keywords: Public space, Neighbourhood, Loneliness, Life satisfaction, Path analysis

Introduction

Within thirty years from now, almost 70% of the world’s population is expected to live in urban areas, thereby increasing the demand for high-quality public spaces (United Nations, 2019). Although researchers have shown the importance of public space on the life satisfaction of residents (Ayala-Azcárraga, Diaz, & Zambrano, 2019), public spaces seem to diminish or reduce in quality in highly urbanized areas (Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg, 2006). Public spaces can promote social interactions between neighbours (Beck, 2009) and can provide opportunities for physical activity (McCarthy & Habib, 2018). Both social interactions and physical activity, promoted by public space use, increase the life satisfaction of residents (Yung, Ho, & Chan, 2017; Larson, Jennings, & Cloutier, 2016). Life satisfaction is defined as a person’s cognitive overall assessment of his or her life (Diener, 1984). Previous research also indicated that people who live in greener neighbourhoods feel less lonely (Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg, 2006). Loneliness is defined as the discrepancy between an individual’s achieved and desired level of social relationships (Perlman & Peplau, 1981).

This study therefore aims to provide insights into personal and neighbourhood characteristics that are related to the use of public space on the one hand and loneliness and life satisfaction on the other hand. A path analysis will be conducted to study the expected relationships simultaneously, of which the insights can be used by policymakers and municipalities to design public spaces that meet the demands of users. The following research questions are formulated:

1. Which personal characteristics and which neighbourhood characteristics influence the use of public space of people?
2. Which personal characteristics and which neighbourhood characteristics influence the life satisfaction of people?
3. Which personal characteristics and which neighbourhood characteristics influence the loneliness of people?
4. How does the use of public space affect the life satisfaction of people?
5. How does the use of public space affect the loneliness of people?
6. How does the loneliness of people influence their life satisfaction?

Literature review

Public space can be defined as a place that is publicly accessible, where people can meet or gather outside (Oldenburg, 1989), such as parks, squares, streets, play areas and civic spaces (Beck, 2009). Attractive public spaces are welcoming, safe, clean and well-maintained, as well as meaningful, comfortable and they should stimulate social interactions between people (Gehl, 2006; Francis, 2003; Beck, 2009). Moreover, it is argued that high-quality public spaces invite residents to be physically active, thereby promoting people's health. Residents who are physically active also have more opportunities for social interactions (Yung, Ho, & Chan, 2017). Opportunities of public space to improve people's life satisfaction and reduce their loneliness in urban areas are also frequently emphasized in previous studies (Zhang & Zhang, 2017; Buffel, Phillipson, & Scharf, 2012).

Loneliness and life satisfaction are influenced by both personal, as well as objective and subjective neighbourhood characteristics. Previously, some authors found a U-shaped relationship between **age** and life satisfaction, with the youngest and oldest residents being most satisfied (Ma, Dong, Chen, & Zhang, 2018). Others did not find a significant direct relationship (Demakakos, Nunn, & Nazroo, 2004). For loneliness, both linear relationships with age (Dykstra, van Tilburg, & De Jong Gierveld, 2005) and U-shaped relationships, where youngest and oldest residents are most lonely (Victor & Yang, 2012), were found. It has also been argued that **gender** is not significantly related to life satisfaction (Ma, Dong, Chen, & Zhang, 2018; Kweon, Ellis, Leiva, & Rogers, 2010), while others argued that women are more likely to be satisfied with their life than men (Weziak-Bialowolska, 2016; Blanchflower & Oswald, 2004). For loneliness, it was found that women more often feel lonely than men (Victor & Yang, 2012). The effects of **ethnic background** on life satisfaction (Parkes, Kearns, & Atkinson, 2002) and on loneliness were found to be rather small (Finlay & Kobayashi, 2018).

The effect of **education** has been explained via the effect of **income** (Marsal-IJacuna, Colomer-Llinàs, & Meléndez-Frigola, 2015). Higher educated residents, generally, have a higher income and are more likely to be satisfied with their life. These residents feel less lonely than lower educated residents or people with lower income (Dykstra & de Jong Gierveld, 1999; Victor & Yang, 2012). Another relationship has been found between **household composition** and life satisfaction. People who live with a partner or with children are more satisfied with their life than people who live alone (Mikucka, 2016; Oswald, Jopp, Rott, & Wahl, 2010) and less often feel lonely (Victor & Yang, 2012). The characteristic **activities of daily living (ADL)** has also been studied for its influence on life satisfaction. People who cannot perform activities of daily living independently, are more likely to be unsatisfied with their life (Oswald, Jopp, Rott, & Wahl, 2010). These residents are also more likely to feel lonely (Hacihasanoglu, Yildirim, & Karakurt, 2012). In addition, the **frequency of use of transport modes** can influence the life satisfaction of people. People who use the car are more satisfied with their life than people who use public transport (Friman, Gärling, Ettema, & Olsson, 2017). People who have access to different modes of transport are found to be less prone of becoming lonely (van den Berg, Kemperman, de Kleijn, & Borgers, 2016).

Next to personal characteristics, objective as well as subjective neighbourhood characteristics can influence the life satisfaction and loneliness of people. An objective characteristic is **maintenance**. People who live in better maintained neighbourhoods are more satisfied with their residence (Fernández-Carro, Módenes, & Spijker, 2015) and are happier (Leyden, Goldberg, & Michelbach, 2011). In contrast, people who live in neighbourhoods where maintenance is lacking, less often use public space, meet fewer people and are therefore more likely to feel lonely (Nath, Han, & Lechner, 2018). The distance to **parks and green areas** also affects people's life satisfaction. People who live further away from green space are less satisfied with their life (Krekel, Kolbe, & Wüstemann, 2016) and people who live in less green neighbourhoods are found to feel lonelier (Maas, van Dillen, Verheij, & Groenewegen, 2009). Moreover, people who have good access to **facilities and services** are more satisfied with their life (von Wirth, Grêt-Regamey, & Stauffacher, 2015). Facilities and services in the neighbourhood provide opportunities for social contacts. People who are satisfied with their social network are less vulnerable of becoming lonely (Kemperman, van den Berg, Weijs-Perrée, & Uijtdewillegen, 2019). Finally, the number of **incidents and crimes** can influence the frequency of visits to public spaces by residents, thereby reducing their life satisfaction (Fleming, Manning, & Ambrey, 2016). In neighbourhoods where the chance of crimes is high, social connections between neighbours are usually weaker (Griffin, 2010). In these neighbourhoods, people are more likely to feel lonely (Prezza & Pacilli, 2007).

Subjective neighbourhood characteristics that influence life satisfaction are **neighbourhood attachment**, social cohesion and the perception of walkability. Residents who feel attached to their neighbourhood, participate more actively in public space, which increases people's life satisfaction (Ayala-Azcárraga, Diaz, & Zambrano, 2019). These residents are also less likely to feel lonely (Weijs-Perrée, van den Berg, Arentze, & Kemperman, 2015). **Social cohesion** also influences the extent to which people feel satisfied with their life (Delhey & Dragolov, 2016). Residents with more social interactions in the neighbourhood are, moreover, found to feel less lonely than other residents (van den Berg, et al., 2019). Finally, the **perception of walkability** is observed to influence life satisfaction via the strength of the communal identity that is felt by residents (Jaskiewicz & Besta, 2014). In green neighbourhoods, where neighbours feel a strong sense of community and have more social interactions (van den Berg, Sharmeen, & Weijs-Perrée, 2017), people are less prone of becoming lonely (Maas, van Dillen, Verheij, & Groenewegen, 2009).

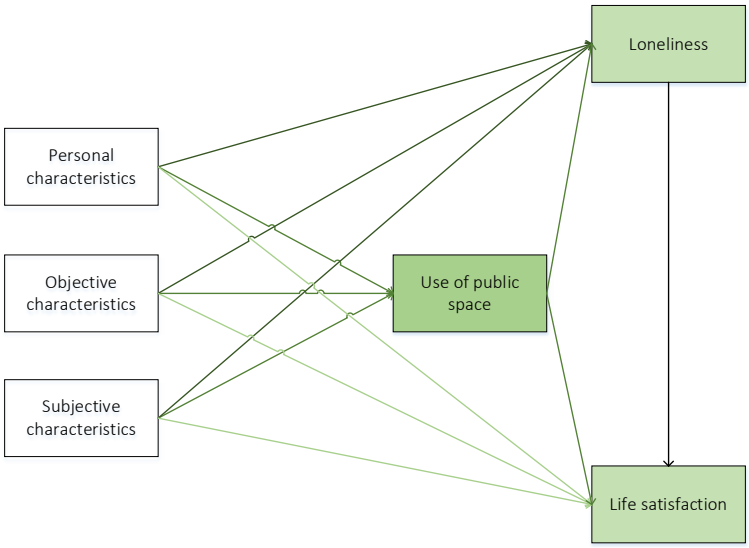

Figure i: Preliminary conceptual model

Research methodology

Based on a literature review, relationships between personal and objective and subjective neighbourhood characteristics and public space use on the one hand and loneliness and life satisfaction on the other hand, were described. To test these relationships, a conceptual model was designed in which the expected relationships were drawn. Figure i shows the conceptual model that was created. Data were collected using a cross-sectional approach, existing of an online questionnaire that was distributed among adults of three neighbourhoods in the middle-sized Dutch city 's-Hertogenbosch; Maaspoort, Binnenstad (inner city) and Rosmalen Zuid. These neighbourhoods differ on the socio-demographics as well as on neighbourhood characteristics, such as the maintenance and the distance to and the number of parks, green areas, facilities and services. The questionnaire was distributed via social media and via meetings with community centres.

After data collection, map-based data, that were collected with the questionnaire, were analysed in QGIS. Maps were created in which the personal and neighbourhood characteristics were linked to the residential location to observe the spatial distribution of participants over the three neighbourhoods. Then, bivariate analyses were performed to observe the significance of the relationships in the conceptual model. These relationships formed the input for the path analysis. The advantage of using a path analysis is that multiple, both direct and indirect relationships between independent and dependent variables can be tested simultaneously.

Data description

In total, 297 participants responded to the questionnaire, of which 200 participants indicated their residential neighbourhood. 97 cases were deleted to be able to use the same sample for all analyses. 53.5% of the respondents indicated to live in Maaspoort, 21.0% in Binnenstad and 25.5% in Rosmalen Zuid. In the sample, most participants are aged above 56 (47.0%), are female (72.5%) and have a high education (55.0%). Most participants indicated to have a moderate income (€1200-€2400 net/month) (41.5%). Almost all participants are Dutch (98.0%) and a mix of household compositions is found. Activities of daily living (ADL) were measured by the Groningen Activity Restriction Scale (GARS), existing of eighteen activities that show the ability or inability of people to perform activities of daily living (Suurmeijer, et al., 1994). For ADL, it is found that most participants are not disabled and can perform daily activities independently (M=21.88). For the frequency of use of transport modes, it is observed that one third of the participants drive a car almost daily, while almost 30% of the participants use a car as a passenger two to five times per week. The number of trips by bus and train are significantly lower.

The subjective neighbourhood characteristics were all based on existing scales. Neighbourhood attachment was measured by the six-item Neighbourhood Attachment Scale (NAS) of Bonaiuto et al. (1999). Only a small percentage of the sample indicated to be very attached to their neighbourhood. For social cohesion, the seven-item scale of Frieling (2008) was used, which measures the joint production, the degree of solidarity and the feelings of involvement in a neighbourhood. Most respondents indicated to frequently chat with their neighbours, sometimes support neighbours when sad events happen, but do however not attend barbecues or neighbourhood parties frequently. The perception of walkability was measured by the Neighbourhood Environment Walkability Scale, existing of 39 statements (Cerin, Saelens, Sallis, & Frank, 2006). In the current study, four of these statements were used to measure walkability.

The use of public space was based on a study by Hadavi and Kaplan (2016) who included three activities to measure the use of public space. The first activity is the frequency of walking or cycling, which exists of eight items, measured on a seven-point scale ranging from never to (almost) daily. The second activity, the frequency of use of specific spaces, exists of seven items which are also measured on a

seven-point scale. The third activity, the frequency of specific activities, includes eight items and is measured on the same scale. A principal component analysis with varimax rotation was performed on the items of these three activities to reduce the items to six components of public space use: recreational use, purposeful use and cycling, gardening, active use, passive use and visit green space.

Loneliness was measured by the three-item loneliness scale, as introduced by Hughes et al. (2004). Most individuals in the sample hardly ever miss companionship, feel left out or feel isolated. Life satisfaction was measured by the Satisfaction With Life Scale of Diener et al. (1985), who used five statements to observe people's satisfaction with life. Some respondents indicated to do things differently if they could live their life over.

Bivariate analysis

Bivariate analyses were carried out to find significant relationships between two variables. The significant relationships were subsequently used in the path analysis, in which relationships are estimated simultaneously. The significance of relationships between personal and subjective and objective neighbourhood characteristics and the six components of public space use were estimated. For **recreational use**, significant effects of income, activities of daily living, neighbourhood, neighbourhood attachment and social cohesion are found. People with higher ADL, residents of Maaspoort and Binnenstad, people who are attached to their neighbourhood and people who reported to live in socially cohesive neighbourhoods, use public space for recreational activities most frequently. **Purposeful use and cycling** is significantly affected by gender, activities of daily living, car use as a driver, bus use and train use, neighbourhood, social cohesion and perception of walkability. Males, people with higher ADL, those who frequently use the train, the bus and those who frequently drive the car, score higher on purposeful use and cycling. Residents of Binnenstad and residents who reported social cohesion and walkability in the neighbourhood to be low, use public space for specific purposes and for cycling less frequently.

For **gardening** no significant relationships are found between any of the personal or neighbourhood characteristics. This variable is therefore deleted from further analysis. For **active use** age, education, activities of daily living, car use as a driver, bus use, train use, neighbourhood and perception of walkability are found to be influential. The youngest residents, people with a high education, with high ADL and people who frequently use the bus or the train, are found to be more likely to actively use public space. In addition, residents of Binnenstad and those who perceived their neighbourhood to be walkable, are also more likely to be active in public space. However, those who frequently drive the car, use public space for active purposes less frequently.

For **passive use** significant effects are found for car use as a driver, bus use, train use, neighbourhood, neighbourhood attachment, social cohesion and perception of walkability. Passive use of public space is found to be higher among frequent train and bus users, among residents of Binnenstad, among people who are attached to their neighbourhood and among people who live in socially cohesive and walkable neighbourhoods. However, frequent car drivers less often passively use public space. **Visit green space** is observed to be significantly influenced by gender, income, household composition, activities of daily living, neighbourhood attachment, social cohesion and the perception of walkability. Green spaces are visited most frequently by males, by people with a high income and by people with a high ADL. Residents who live alone less frequently visit green space than residents who live in couples without children. Residents who are attached to their neighbourhood or who live in socially cohesive and walkable neighbourhoods visit green space more frequently than other residents.

Gender, household composition, activities of daily living, social cohesion, perception of walkability, passive use and visit green space are, moreover, found to significantly affect **loneliness**. Females,

residents who live alone and who have lower ADL more often feel lonely. Contrastingly, people who reported social cohesion or walkability to be high, are less likely to feel lonely. People who visit green space or who use public spaces for passive activities frequently, also less often feel lonely. Finally, life satisfaction is significantly influenced by household composition, activities of daily living, social cohesion, perception of walkability, active use, visit green space and loneliness. Residents who live alone and who have lower ADL, are found to be more dissatisfied with their life. People who live in socially cohesive or walkable neighbourhoods are more satisfied with their life. Residents who actively use public space or who visit green space frequently, are also more satisfied with their life. Finally, a relationship between loneliness and life satisfaction is found, with lonely residents being more likely to be dissatisfied with their life, and the other way around.

Path analysis

The bivariate analyses that have been performed between the independent and dependent variables showed significant relationships. These relationships were added to the path model. The relationships that were not significant in the path analysis were deleted by the backward stepwise process until an acceptable model fit was found and all insignificant relationships were deleted from the model. An RMSEA of 0.089 was found, which indicates a modest fit of the data to the model.

For recreational space use, significant effects of age, activities of daily living, neighbourhood and neighbourhood attachment are found. Older residents and people with a higher ADL more frequently use public space for recreational activities. Although this relationship has not been found in previous studies, research did show that residents with functional limitations walk significantly less for recreational purposes than residents without functional limitations (van Cauwenberg, et al., 2015). Residents of Binnenstad and Maaspoort and people who are attached to their neighbourhood also more frequently use public space for recreational activities.

Purposeful space use and cycling is significantly associated with train use, neighbourhood, social cohesion and perception of walkability. Frequent train users more often use public space for recreational purposes. It could be that both train use and public space use demands users to have a certain level of functional capability, meaning that train users are more capable of using public space. To the best of the author's knowledge, previous studies have not found this relationship. Residents of Maaspoort and Binnenstad and people who live in socially cohesive and walkable neighbourhoods are also found to use public space for purposeful activities or for cycling more frequently. Hadavi and Kaplan (2016) argued that a lack of social cohesion and walkability limits residents in their use of public space.

Active use is significantly affected by education, train use, neighbourhood and perception of walkability. Residents with a high education, people who frequently use the train, people who live in Binnenstad and people who live in walkable neighbourhoods more often actively use public space. Van Dyck et al. (2013) also found that neighbourhood walkability contributes to more active public space use. Passive use is significantly influenced by activities of daily living, car use as a driver, neighbourhood, neighbourhood attachment and social cohesion. People with a lower ADL and people who frequently drive the car, less often passively use public space. While public transport users usually have to walk to train or bus stations, car drivers can immediately get into their car without having to walk. This may be an explanation of the lower frequency of public space use among car drivers compared to train users. In contrast, residents of Binnenstad and people who are attached to their neighbourhood or who live in socially cohesive neighbourhoods more frequently passively use public space.

For visit green space significant relationships are found with income, household composition, neighbourhood attachment, social cohesion and perception of walkability. People with a high monthly income, who live in couples with or without children, who are attached to their neighbourhood and

residents of neighbourhoods with high social cohesion and walkability, visit green spaces most frequently. Previous studies showed a general tendency of young families who expect children or who have children to move to family houses close to nature (Haase, Lautenbach, & Seppelt, 2010; Raymond, Gottwald, Kuoppa, & Kyttä, 2016).

For loneliness, significant associations are found with household composition, activities of daily living, social cohesion and passive space use. Single persons and persons with lower ADL feel lonelier than couples with or without children and people with higher ADL. A significant effect of age on loneliness has not been found. It is found that the dependence on others increases with age, indicating that age differences in loneliness are probably affected by differences in ADL. People who live in neighbourhoods with high social cohesion or who frequently use public space for passive activities, are, moreover, found to be less lonely. Finally, activities of daily living, social cohesion, active use and loneliness significantly affected life satisfaction. Residents with high ADL and who live in socially cohesive neighbourhoods, are more likely to be satisfied with their life. In addition, residents who frequently actively use public space or who never feel lonely, more often are satisfied with their life. Borg et al. (2008) also finds that loneliness is significantly related to life satisfaction.

Conclusion, discussion and recommendations

The aim of this study was to provide insights into the personal and neighbourhood characteristics that are related to the use of public space on the one hand and loneliness and life satisfaction on the other hand. The lack of accessible, high-quality public spaces for all residents of our rapidly ageing and urbanizing society is one of the main challenging urban problems. Especially in these urbanized environments, public spaces where residents can relax, recreate and escape from their daily lives, are increasingly needed.

Five uses of public space were distinguished: recreational use, purposeful use and cycling, active use, passive use and visits to green space. Recreational public space use exists, for example, of items that indicate the use of parks and green spaces for leisure purposes, whereas passive space use exists of items that indicate passive activities, such as sitting and watching and gathering outdoors. The personal characteristics that were found to be related to public space use are educational background, income and household composition. Age was only found to significantly affect recreational space use, indicating that older residents more often use public space for recreational purposes than younger residents. Although expected, no significant influence of age on loneliness or life satisfaction was found. It was shown that age differences in loneliness and life satisfaction were affected by differences in ADL.

The subjective neighbourhood characteristics; neighbourhood attachment, social cohesion and the perception of walkability were also found to play a major role in the use of public space and the extent to which residents feel satisfied or lonely. This study indicated that people use public space significantly more often in highly walkable and socially cohesive neighbourhoods and in neighbourhoods to which they feel attached. People who live in socially cohesive neighbourhoods were also found to be more satisfied with their life.

The results of the study have implications for various stakeholders, such as municipalities, urban planners and developers of public space. Firstly, supportive neighbourhoods with high-quality, accessible public spaces should be designed that help to reduce loneliness and increase life satisfaction of residents. These neighbourhoods should be highly walkable and should invite people to go outside and to meet neighbours. To further promote life satisfaction and reduce loneliness among residents, policymakers should strive to develop public spaces that increase social cohesion and neighbourhood attachment. In ‘s-Hertogenbosch, a focus should be on the connection between the inner city and public spaces at the outskirts by the development of walking and bicycling paths. These paths, as well as the

expansion of the car-free environment in the inner city, are expected to support the walkability of the city and the accessibility of public space.

Although the results provided valuable relationships, some limitations to the study are also found. Firstly, the sample that was derived differs substantially from the population in the Netherlands and in 's-Hertogenbosch. The differences between the three selected neighbourhoods were, moreover, found to be influential. Outcomes of the study should, therefore, only carefully be generalized to other Dutch cities. Only one of the five components of public space use was found to affect loneliness and life satisfaction. The focus on the frequency of public space use instead of a focus on the distance or quality of public space may have caused the weaker than expected relationships.

Future research should, firstly, try to overcome the limitations of the current study, by gaining a more mixed and a larger sample. Focusing on disadvantaged neighbourhoods or neighbourhoods with a large percentage of elderly may also be of interest. Finally, more extensive characteristics of public space use can be included in future research, such as the distance and the quality of public space. By including these characteristics, it can be observed whether people would be more satisfied and would be less lonely if public spaces would be closer to the residential location or of higher quality.

Table of Contents

1. Introduction

This chapter introduces the objectives of the current study, to gain an understanding in the extent to which people use public space and how public space use influences the satisfaction and loneliness of people. In this study, insights will be gained by using a questionnaire about personal and neighbourhood characteristics as well as the loneliness and life satisfaction of people. This section will first describe the problem, after which the research objective and research questions are introduced. The relevance and method will also shortly be described.

1.1. Background

The belief that exposure to nature, such as trees and water, promotes well-being and life satisfaction, dates as far back as the rise of the first cities. The ancient residents of Rome wrote, for instance, that they valued the contact with nature to escape from the noise and congestion of the city (Ulrich, et al., 1991). In the urbanizing society in which we live nowadays, there is a growing need for nature and public open spaces to escape from our hectic city lives, to relax and to recreate (Gezondheidsraad, 2004). Within thirty years from now, almost 70% of the world's population is expected to live in urban areas, increasing the demand of high-quality public spaces (United Nations, 2019). In recent years, however, public spaces seem to diminish or reduce in quality in highly urbanized areas (Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg, 2006). The increase in population density in urban areas results in poorer health and quality of life of its residents (Cramer, Torgersen, & Kringlen, 2004).

Previously, the health and well-being effects of public spaces have been examined (Fleming, Manning, & Ambrey, 2016). Public spaces, such as parks, squares, streets, play areas and civic spaces, can promote social interaction between neighbours (Beck, 2009) and can provide opportunities for physical activities (McCarthy & Habib, 2018). Social interactions between neighbours in public space contribute to higher life satisfaction. It is therefore suggested that planning and design managers should pay more attention to the social connections between residents in a neighbourhood (Yung, Ho, & Chan, 2017). Moreover, physical activity in public space supports the physical health of people, thereby increasing their well-being and satisfaction with life (Larson, Jennings, & Cloutier, 2016).

Life satisfaction can be defined as a person's cognitive overall assessment of his or her life (Diener, 1984). The extent to which an individual is satisfied depends on different factors, such as personal characteristics, but also on various neighbourhood characteristics. For instance, people who live close to high quality, well-maintained and illuminated parks are found to be more satisfied with their life than people who live further away (Ayala-Azcárraga, Diaz, & Zambrano, 2019). For older people specifically, living within walking distance of safe and pleasant open spaces affects life satisfaction (Sugiyama & Alves, 2009).

Next to the effects of public space use on life satisfaction, previous research indicated that people who live in greener neighbourhoods, generally, feel less lonely than people who live further away from green spaces (Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg, 2006). In addition, people who visit public spaces frequently, are less prone of becoming lonely (van den Berg, et al., 2019). Here, loneliness can be defined as the discrepancy between an individual's achieved and desired level of social relationships (Perlman & Peplau, 1981).

Previous studies also investigated the influence of personal and neighbourhood characteristics on both public space use and loneliness and life satisfaction. Personal characteristics, such as age, gender and educational background are found to influence loneliness (Victor & Yang, 2012; Dykstra & de Jong Gierveld, 1999) and life satisfaction (Weziak-Bialowolska, 2016; Cao, 2016; Baum, Arthurson, & Rickson, 2010). The effects of neighbourhood characteristics, such as social cohesion and neighbourhood attachment on loneliness (Weijs-Perrée, van den Berg, Arentze, & Kemperman, 2015; van den Berg, et

al., 2019; Maas, van Dillen, Verheij, & Groenewegen, 2009) and life satisfaction (Clark, Duque-Calvache, & Palomares-Linares, 2015; Brajša-Žganec, Merkaš, & Šverko, 2011) are also previously observed. However, an analysis in which both personal and neighbourhood characteristics are used to understand the loneliness and life satisfaction, mediated by the effect of public space use, is still lacking.

1.2. Problem description

As previously described, public spaces in cities disappear or reduce in quality (Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg, 2006). Recent findings of the World Health Organisation (WHO) indicate that, worldwide, more than half of the adult population does not comply with the daily physical activity recommendations (WHO, 2010), while public spaces are considered to be important locations for physical activity (van Herzele & de Vries, 2012; van Hecke, et al., 2018). A lack of high-quality public spaces results in lower self-perceived health, higher morbidity and mortality rates, obesity, stress and reduced life satisfaction (van Herzele & de Vries, 2012). The frequency of visits to public space also affects the extent to which residents feel lonely (van den Berg, et al., 2019) or feel satisfied with their life (Hadavi & Kaplan, 2016). However, policy makers and municipalities may not be fully aware of the possible contributions of public space use to health, reduced loneliness and increased life satisfaction of residents.

1.3. Research objective

With regards to the increasing urbanization in the Netherlands and the reduced quality of public space, the primary objective of the current study is to provide insights into the personal and neighbourhood characteristics that are related to the use of public space. These characteristics can also be used to explain the loneliness and life satisfaction of urbanized areas in the Netherlands. A path analysis will be used to study the expected relationships simultaneously. The insights that are gained can be used by policymakers, municipalities and developers of public space to design neighbourhoods where public spaces are present and accessible to reduce people's loneliness and increase their satisfaction with life.

1.4. Research questions

The research approach is based on the framework that was introduced by Amerigo and Aragones (1997). Their model showed that life satisfaction can be determined by both objective and subjective neighbourhood characteristics as well as personal characteristics. The current study adds the relationships between both personal and neighbourhood characteristics and loneliness. In addition, this study integrates the use of public space in the framework to understand the effect of personal and neighbourhood characteristics on the use of public space. Moreover, the effect of public space use on loneliness and life satisfaction can be investigated. Finally, the relationship between loneliness and life satisfaction will be studied. The research questions are formulated as follows:

1. Which personal characteristics and which neighbourhood characteristics influence the use of public space of people?
2. Which personal characteristics and which neighbourhood characteristics influence the life satisfaction of people?
3. Which personal characteristics and which neighbourhood characteristics influence the loneliness of people?
4. How does the use of public space affect the life satisfaction of people?
5. How does the use of public space affect the loneliness of people?
6. How does the loneliness of people influence their life satisfaction?

Figure 1.1 illustrates the preliminary conceptual model, which can be used to gain first insights into relationships that are expected. Firstly, the objective and subjective neighbourhood characteristics and the personal characteristics are shown to be related to public space use. The use of public space is also related to satisfaction with life and loneliness. The personal characteristics and objective and subjective neighbourhood characteristics are also expected to influence life satisfaction and loneliness of people directly. A relationship between loneliness and life satisfaction is expected as well.

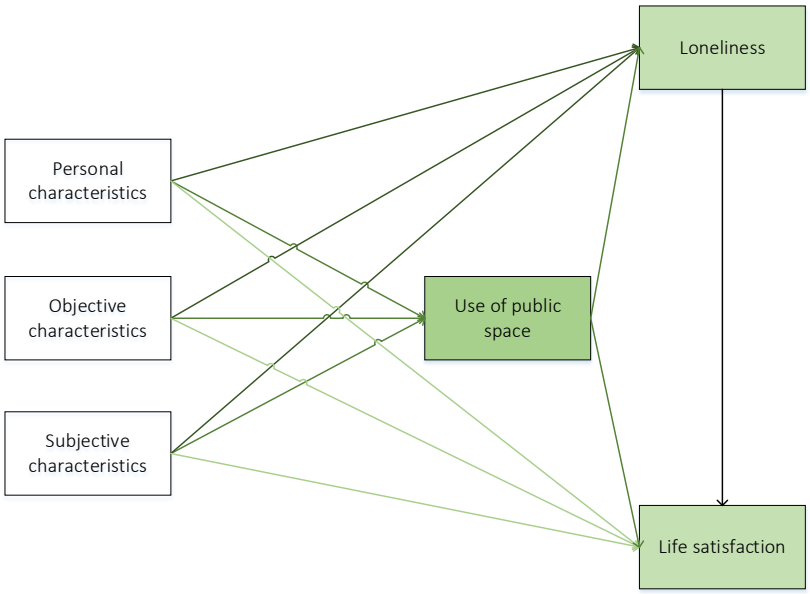

Figure 1.1: Preliminary conceptual model

1.5. Relevance

1.5.1. Scientific relevance

This study attempts to contribute to the existing body of literature by providing a better understanding of the effect of use of public space by residents on their life satisfaction and loneliness. The study has a country-specific approach for the Netherlands, in which insights will be provided for policymakers, researchers and municipalities in the Netherlands. The findings of the relationships between use of public space and satisfaction with life and loneliness expand current knowledge about the indicators of life satisfaction and loneliness. Previous research mainly focused on one of the relationships between use of public space, loneliness and life satisfaction. This study attempts to study these relationships simultaneously, thereby providing valuable insights which can be used in future research at larger scale, in different cultures and countries.

1.5.2. Societal relevance

As was previously described, policy makers may not be fully aware of the added value of public space use to the health and life satisfaction of residents. Therefore, this research provides insights into the contribution of public space use to people's health (Larson, Jennings, & Cloutier, 2016), social interactions with neighbours (Beck, 2009), life satisfaction (Hadavi & Kaplan, 2016) and the reduction of loneliness (van den Berg, et al., 2019) The current study's aim to gain a better understanding of the personal and objective and subjective neighbourhood characteristics that affect public space use, has strong societal relevance. The gained insights can be used by municipalities in design and development decisions of public space to improve the life satisfaction and reduce the loneliness of all residents of a neighbourhood.

1.6. Research method

In this study, various research methods will be applied to answer the main research questions. Firstly, a literature study will be conducted to get a more comprehensive understanding of the indicators that are related to public space use, life satisfaction and loneliness. The literature findings will be used to create a conceptual model, which provides an overview of personal and neighbourhood aspects that influence life satisfaction and loneliness.

After the literature study, a web-based questionnaire will be composed, in which residents of three specific neighbourhoods can participate. The program Maptionnaire will be used to collect data about the personal characteristics and subjective neighbourhood characteristics of participants. Data will also be retrieved about the extent to which participants feel lonely or satisfied with their life. In Maptionnaire, respondents will also be asked to draw their residential location and public spaces that they frequently visit on a digital map.

These map-based data will be analysed in the geographical software package QGIS. Here, all frequently used public spaces and residential locations will be collected. Maps can be created that visualize the personal and subjective neighbourhood characteristics of participants of the survey and that show the frequently used public spaces in the neighbourhood.

The statistical program SPSS will be used to perform the descriptive analyses and bivariate analyses, to gain first insights into the significant relationships between the personal and neighbourhood characteristics and public space use, loneliness and life satisfaction. After bivariate analyses, a path model can be created in the statistical package LISREL. All significant relationships of the bivariate analyses will be added to the path model. A backward stepwise process will be repeated until all insignificant relationships are removed and an acceptable model fit is found.

1.7. Thesis outline

Firstly, chapter 2 reviews the existing literature on the characteristics public space use, loneliness and life satisfaction, as well as the personal and neighbourhood characteristics. The chapter is concluded by the conceptual model, consisting of all personal and neighbourhood characteristics that are expected to influence both loneliness and life satisfaction. In chapter 3, the research method and data collection are explained. Next, chapter 4 describes the descriptive statistics that are carried out in SPSS. In chapter 5, the bivariate analyses that are performed between the dependent and independent variables are explained. The significant relationships are the input of the path analysis of chapter 6. In this chapter, the final conceptual model with significant relationships is presented. Finally, chapter 7 concludes the thesis with a discussion of the results. Recommendations and possibilities for further research are also presented in chapter 7.

2. Literature review

In the introductory chapter, the motivation to study the use of public space, loneliness and life satisfaction was explained. In this chapter, a definition of public space will be given, followed by a definition of the concepts life satisfaction and loneliness. This chapter also explains which personal, objective and subjective neighbourhood characteristics influence life satisfaction and loneliness.

2.1. Public space

Public spaces are places that are publicly accessible, where people meet or gather outside home (Oldenburg, 1989). Public spaces can be parks, squares, streets, play areas but also civic spaces (Beck, 2009). Interactions and opportunities to have contact are fostered at these spaces. Public spaces should have attractive physical environmental features. Public spaces should be meaningful and comfortable and should be designed to meet people and to have social interactions (Gehl, 2006; Francis, 2003). Social interactions that take place in public spaces reduce the risk of people becoming lonely (Van den Berg, Kemperman, de Kleijn, & Borgers, 2015). Generally, people who live in neighbourhoods with a lack of green space more often feel lonely than people who live in greener environments (Maas, van Dillen, Verheij, & Groenewegen, 2009).

2.1.1. Activities and use public space

Public spaces should be welcoming, healthy, safe and secure, clean, well-maintained and sustainable in order to be frequently used (Beck, 2009). Various kinds of activities can be performed in public space, such as watching or playing a sport, visiting events, walking or running, relaxing and walking the dog (Francis, Giles-Corti, Wood, & Knuiman, 2012; Hadavi & Kaplan, 2016). Hadavi and Kaplan (2016) argue that the use patterns of public space are complex interplays between individual preferences and environmental attributes.

The use of public space can be measured as the frequency and duration of visits to specific places. People who frequently visit public spaces are more likely to be satisfied with these spaces, due to the promotion of social interactions and social contacts at these spaces (Ayala-Azcárraga, Diaz, & Zambrano, 2019). It is believed that high-quality public spaces invite residents to be physically active, promoting people's health. These residents have more opportunities to have social interactions with other residents (Yung, Ho, & Chan, 2017). Residents with easy access and short distance to public spaces, moreover, report higher satisfaction with public space than residents who do not have easy access (Bedimo-Rung, Mowen, & Cohen, 2005). People who live in proximity of parks that are clean, natural and well illuminated, are expected to visit public spaces more frequently and for a longer period (Ayala-Azcárraga, Diaz, & Zambrano, 2019).

Public spaces with facilities, such as sport fields, paths and trails, playgrounds, picnic areas and restrooms, are also more frequently used and for a longer period (Bedimo-Rung, Mowen, & Cohen, 2005). Next to the frequency of use, the quality of space affects the satisfaction of people (Hadavi & Kaplan, 2016). Residents who are satisfied with the quality of public space are also more likely to be satisfied with their life in general (Fleming, Manning, & Ambrey, 2016).

Especially in highly urbanized areas, the need for public space increases (Gezondheidsraad, 2004). In these areas, public spaces should function as "ecological lungs of a city", or as "social spaces open to all citizens" or as "places for passive and active recreation" (Duan, Wagner, Zhang, Wulff, & Brehm, 2018). However, in recent years public spaces seem to diminish or reduce in quality in highly-urbanized areas (Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg, 2006). Opportunities of public space to improve people's life satisfaction and reduce their loneliness in urbanized environments are frequently emphasized in previous studies (Zhang & Zhang, 2017; Buffel, Phillipson, & Scharf, 2012).

2.1.2. Users of public space

Activities that are performed in public space depend on the personal characteristics of an individual, such as the age and gender. It is, for instance, argued that single, younger and older residents are more likely to live in urban neighbourhoods where fewer possibilities are available for natural activities. Families with children and middle-aged people, are, in contrast, more likely to live in family houses that are close to nature (Raymond, Gottwald, Kuoppa, & Kyttä, 2016). For families with children, public spaces provide opportunities to meet other parents and for children to play outside (Cattell, Dines, Gesler, & Curtis, 2008). Facilities in public space can invite residents of all age groups to go outside (van Hecke, et al., 2018).

Ageing residents mainly use public space to walk and cycle, to spend time with friends and family and to be in contact with nature (Thompson & Aspinall, 2011). Since elderly rely on cycling and walking as main transport modes, public spaces should be easily accessible and should be within ten minutes walking distance (Duan, Wagner, Zhang, Wulff, & Brehm, 2018). Walkable public spaces are rated as important opportunities for physical activity among elderly (Kaczynski, Potwarka, & Saelens, 2008) and can also foster a feeling of belonging and connection within the neighbourhood (Moudon, et al., 2006). Among elderly specifically, regular exposure to green space can strengthen their social ties and social integration in the neighbourhood (Bedimo-Rung, Mowen, & Cohen, 2005).

Next to the age and gender of individuals, the income of people is found to affect their use of public space. In neighbourhoods where the average household income is low, the percentage of green space is lower than in neighbourhoods where the average household income is high (Astell-Burt, Feng, Mavoa, Badland, & Giles-Corti, 2014). Moreover, people who own a car usually have higher incomes and therefore have greater access to green spaces that are at a further distance (Pasaogullari & Doratli, 2004; Wüstemann, Kalisch, & Kolbe, 2017).

2.1.3. Barriers to use public space

Barriers to use public space are, for instance, lacking maintenance, cleanliness, feelings of unsafety among residents and lacking illumination. These spaces are used less frequently than public spaces that are clean and well illuminated. Less frequent use of public space due to a lack of maintenance, lighting and safety results in fewer social interactions between neighbours (Ayala-Azcárraga, Diaz, & Zambrano, 2019). The reduction of vandalism, litter and damage and increasing safety and comfort of public space should be one of the main concerns of a municipality (Dempsey & Burton, 2012).

Next to maintenance and safety, a lack of variety in green space also results in less frequent use of public space for recreation, walking and for socializing (Hadavi & Kaplan, 2016). Public spaces that are not interconnected by trails or paths, limit physical activity possibilities of residents and reduce the chances of spontaneous social interactions between neighbours (Kaczynski, Potwarka, & Saelens, 2008). Limited social opportunities in public spaces increase vulnerable residents of feeling lonely (Finlay & Kobayashi, 2018).

2.2. Life satisfaction

Life satisfaction can be defined as a person's cognitive overall assessment of his or her life and is one of the three components of subjective well-being, next to positive and negative affect (Diener, 1984). The environmental-ageing model shows that objective and subjective characteristics may determine life satisfaction (Smith, Sim, Scharf, & Phillipson, 2004). Amerigo and Aragones (1997) argue that people evaluate the objective attributes of a neighbourhood and become subjective. The subjective evaluation of the neighbourhood may influence the satisfaction of the individual with his or her life in general.

Life satisfaction is dependent on personal factors, such as gender and age (Borg, et al., 2008; Dubrovina, Siwiec, & Ornowski, 2012; Joshanloo, 2018), income (Helliwell, Layard, & Sachs, 2012), mental and

physical health and education (Powdthavee & Lekfuangfu, 2015). Neighbourhood characteristics, such as the distance to public space and facilities (Thompson & Aspinall, 2011) and subjective neighbourhood characteristics, such as neighbourhood attachment (Zhang & Zhang, 2017) and perception of walkability (Jaskiewicz & Besta, 2014) also influence life satisfaction.

Most of previous studies focus on either the influence of personal factors or the influence of neighbourhood factors on life satisfaction. It is, however, important to understand how all these factors influence life satisfaction simultaneously. There is no "one-model-fits-all" solution to the ideal neighbourhood for residents. A wide range of specific neighbourhood characteristics, both subjective and objective, should therefore be considered to understand demands and needs of residents (Wiles, Leibing, Guberman, Reeve, & Allen, 2011).

2.3. Loneliness

Loneliness can be defined as the discrepancy between an individual's achieved and desired level of social relationships (Perlman & Peplau, 1981). Although humans are designed to live in close communities, in recent years life became more isolated from others. The percentage of one-person households is increasing, due to an ageing population and fewer children being born. More people divorce and careers and education forces people to live further away from family and friends. All these developments may increase the extent to which individuals feel isolated and lonely (Griffin, 2010).

The lonelier our society, the more likely individuals are to experience loneliness due to a clustered spread of loneliness via the social network. Every individual will feel lonely during some life stage. In middle age, people may feel lonelier due to retirement and children moving out of home. Loneliness among elderly is linked to social exclusion. Factors such as having a poor health, renting instead of owning a residence and not being married may increase the risk of feeling socially excluded (Griffin, 2010). Other factors, such as gender, age and health are also often examined for their influence on loneliness (Rokach, 2019).

2.4. Personal characteristics

Personal characteristics such as age, gender, self-perceived health, income and education are often examined in previous studies on their effect on life satisfaction and loneliness, since these factors influence the preferences of individuals and their aspirations in life (Ma, Dong, Chen, & Zhang, 2018). This section discusses the most important personal characteristics and their influence on life satisfaction and loneliness.

2.4.1. Age

Age is found to be related to life satisfaction, with middle-aged people being more likely to be unsatisfied with their life, compared to younger and elder residents (Ma, Dong, Chen, & Zhang, 2018). The U-shape in age, with a decline in life satisfaction in people's late thirties, may be caused by a process of adaptation to certain circumstances. For instance, people have to adapt to changing household responsibilities, such as raising children and children moving out of house (Cao, 2016). People may also relinquish some of their aspirations by the middle of their lives and start to enjoy their lives more when they turn older (Blanchflower & Oswald, 2004).

People with a lower health, generally, report lower life satisfaction than healthier people (Demakakos, Nunn, & Nazroo, 2004). Unless the fact that elderly are less likely to report good health (Ma, Mitchell, Dong, & Zhang, 2016), they are still more likely to be satisfied with their life. Pinto et al. (2016) argue, therefore, that age is not directly related to life satisfaction, but indirectly through negative consequences of life, such as health disabilities.

Next to the relationship between age and life satisfaction, a relationship between age and loneliness is expected. Previous studies explained the relationship in two ways. In some studies, it is argued that a linear relationship exists between age and loneliness, while in other studies it is argued that a U-shaped relationship exists. For instance, the longitudinal data collected by Dykstra, van Tilburg and de Jong Gierveld (2005) support that the oldest residents of a neighbourhood feel most lonely and that loneliness increases over time. Others find a U-shaped distribution of loneliness for both males and females, where people who are younger than 25 and people who are above 65, are more likely to be lonely than people of middle-age (Victor & Yang, 2012).

2.4.2. Gender

Broadly, previous studies found mixed results of the effect of gender on life satisfaction (Batz & Tay, 2017). For instance, Ma et al. (2018) and Kweon et al. (2010) argued that gender is not significantly related to life satisfaction. Contrastingly, Weziak-Bialowolska (2016) and Blanchflower and Oswald (2004) argued that women are more satisfied with their life than men. The general increase in life satisfaction of women can be explained by the gender equality throughout the world. In many countries males and females are equal, but inequality is still significant (Inglehart, 2002). Figure 2.1 shows the interaction between gender, age and life satisfaction. Until the age of 35 to 44, women are more satisfied with their life than men. After this age, men report higher satisfaction with life than women (Inglehart, 2002).

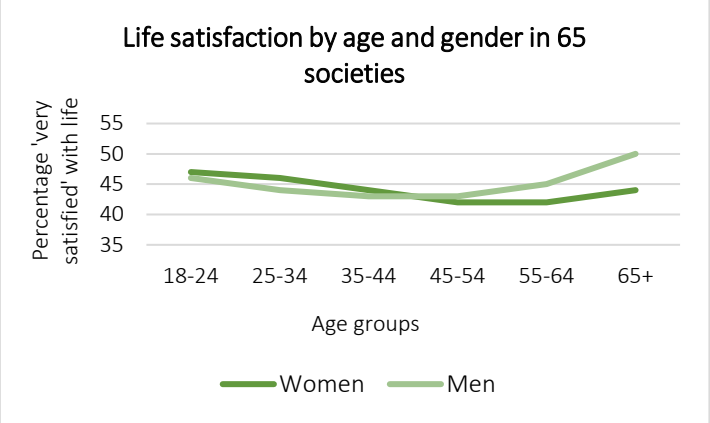

Figure 2.1: Life satisfaction by age and gender (based on Inglehart, 2002)

Overall, gender differences in the prediction of life satisfaction are small. For males, political-, employment- and education-related aspects of life are important attributes of life satisfaction. Unemployment among males has a more negative effect on life satisfaction than unemployment among females. For women, marital status and interpersonal relationships were found to be important attributes for satisfaction with life (Joshanloo, 2018).

Males and females may also differ in the extent to which they feel lonely. In general, females feel lonelier than males. The extent to which females and males feel lonely, also depends on the age of the individual. Figure 2.2 shows that for males, loneliness feelings are stable until the age of 74. For women, an increase in loneliness is observed after the age of 55. Victor and Yang (2012) argue that the increase in loneliness over time is triggered by different factors between males and females and by the occurrence of life events or experiences.

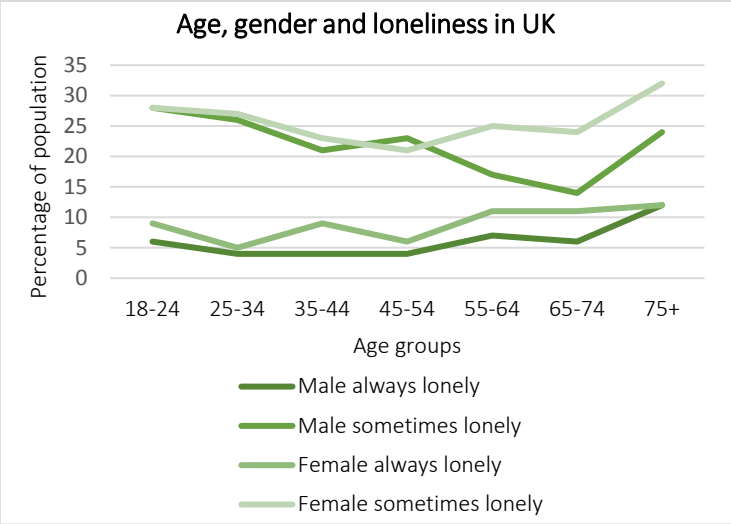

Figure 2.2: Loneliness by age and gender (based on Victor & Yang, 2012)

2.4.3. Ethnic background

Some authors also found the effect of ethnic background on life satisfaction. It is, for instance, argued that ethnic minorities are less satisfied with their life than majorities (Knies, Nandi, & Platt, 2016; Blanchflower & Oswald, 2004). Others argue that the effect of ethnicity is small (Parkes, Kearns, & Atkinson, 2002) or even negligible (Okulicz-Kozaryn & Mazelis, 2018). The effect of ethnic background on loneliness is, according to previous studies, also insignificant (Finlay & Kobayashi, 2018). Although Blacks and Hispanics are found to be at larger risk of becoming lonely, differences in loneliness are mainly explained by differences in education and income (Hawkley, et al., 2008).

2.4.4. Education

Nowadays people invest in education, because they hope to generate more wealth to become happier (Powdthavee & Lekfuangfu, 2015). Previous research has explained education as an indicator of life satisfaction through the effect of income (Marsal-IJacuna, Colomer-Llinàs, & Meléndez-Frigola, 2015). People with higher levels of education are also found to have higher incomes (Parkes, Kearns, & Atkinson, 2002) and higher incomes predict higher life satisfaction (Gere & Schimmack, 2017). Other findings show that education is indirectly related to life satisfaction, via income, employment, marriage and health. These indirect relationships are found to be statistically significant (Powdthavee & Lekfuangfu, 2015). People who have had a higher level of education are, in addition, more likely to live in proximity of green spaces, which can also affect the satisfaction with life (Wüstemann, Kalisch, & Kolbe, 2017).

Previous research determined an indirect relationship between education and life satisfaction through negative consequences, such as social disadvantage and exclusion (Pinto, Fontaine, & Neri, 2016). The difference in access to education between women and men leads to differences in the ability to meet their needs, resulting in lower life satisfaction among women (Batz & Tay, 2017). Education-related variables (Joshanloo, 2018) and employment-related variables (Powdthavee & Lekfuangfu, 2015) are more important determinants of life satisfaction among men than among women. Other studies, such as the study by Ma et al. (2018) showed that life satisfaction of people is directly influenced by their level of education. Life satisfaction was reported to be higher among higher educated individuals, especially among individuals who attended a tertiary education.

Next to the direct or indirect relationship between education and life satisfaction, a relationship between education and loneliness is expected. Victor and Yang (2012) argue that protective factors, such as having a larger household size, being married, having a good health, but also having a tertiary

education limit the vulnerability of people of becoming lonely. People with a low education were found to be at greater risk of having small social networks and of having less possibilities for social participation. These residents are therefore more prone of becoming lonely (Dykstra & de Jong Gierveld, 1999).

2.4.5. Income

Income explains the commercial and social opportunities of an individual and the extent to which an individual can use paid services, now and in later life. Having a higher income enables people to engage in social activities and to pay for demanded services (Pinquart & Sorensen, 2001). This improves life conditions and people's well-being, resulting in an increase in life satisfaction (Helliwell, Layard, & Sachs, 2012). Generally, higher income leads to higher life satisfaction (Gere & Schimmack, 2017; Fleming, Manning & Ambrey, 2016). The relationship between income and life satisfaction is, however, not expected to be linear. For the poorest, money can buy happiness, but becoming wealthier does not necessarily increase life satisfaction further. The effect of income on life satisfaction thus flattens for people with higher incomes (Helliwell & Putnam, 2004).

Just as for the effect of education on loneliness, the effect of income on loneliness is explained by the social participation and social networks of people. In general, people with a lower income have fewer opportunities of social participation and have smaller social networks, increasing the risk of becoming lonely (Dykstra & de Jong Gierveld, 1999). The effect of income on loneliness can also be explained by the association with health. People who have a high income, but a limited health are still prone of feeling lonely (Hawkley, et al., 2008).

2.4.6. Household composition

People who live with a partner are more satisfied with their life than people who live alone. Especially among people above the age of 65, living with a partner is a strong predictor of life satisfaction (Oswald, Jopp, Rott, & Wahl, 2010). Having children is also found to increase the life satisfaction of people. The long-term effect of parenthood on life satisfaction is positive, meaning that having children results in an increase of life satisfaction. Especially among females, the birth of a child causes a significant increase in satisfaction with life (Mikucka, 2016).

The household composition, the household size and the marital status of an individual, are all related to the loneliness of people, especially among middle-aged and older adults. The extent to which middle-aged and elderly feel lonely depends on the household composition. Being married or living in larger households instead of living alone protects people from feeling lonely (Victor & Yang, 2012).

2.4.7. Activities of daily living

The activities of daily living (ADL) such as bathing, dressing and eating are activities that are often used to measure the functional ability or disability of older people (Subaş & Hayran, 2005). Activities that reduce most often are the ability to prepare meals, to get to places not within walking distance and to do cleaning. People who reported lower ADL functioning were determined to be less satisfied with their life (Borg, et al., 2008) and to be lonelier (van den Berg, Kemperman, Uytdewilligen, & Weijs-Perrée, 2016). Among the oldest residents of a neighbourhood, being able to function independently is one of the most important contributors to life satisfaction (Oswald, Jopp, Rott, & Wahl, 2010). The independency of people is influenced by age, marital status, health and self-perceived health. People who are widowed or divorced, who have a chronic disease or who perceive their health to be poor are more likely to be dependent on others. These residents are more prone of feeling lonely (Hacihasanoglu, Yildirim, & Karakurt, 2012).

2.4.8. Car use and public transport use

The travel mode that is available to an individual affects the travel satisfaction and indirectly affects emotional well-being and life satisfaction of people. People who use active modes of transport or the car are generally more satisfied with their daily travels than people who use public transport (Friman, Gärling, Ettema, & Olsson, 2017). People who make more daily trips, and who participate in social activities, are also more satisfied with their life. Traveling to these activities by different transport modes and having greater access to travel options affects the life satisfaction of people. When people own more vehicles, they are also more likely to be satisfied with their life. This can be caused by a sense of freedom, pride or happiness which is felt when owning a vehicle (McCarthy & Habib, 2018).

In line with the effect of having access to different transport modes on life satisfaction, is the effect on loneliness. When people have access to transport modes, such as public transport, or when they own a car, the opportunities to participate and to interact with others increase. People who own a car or who use a car are found to be less lonely than people who have limited access to mobility (van den Berg, Kemperman, de Kleijn, & Borgers, 2016).

2.5. Objective neighbourhood characteristics

The environmental-ageing model shows that objective and subjective characteristics determine life satisfaction (Smith, Sim, Scharf, & Phillipson, 2004). This section discusses the most important objective neighbourhood characteristics.

2.5.1. Maintenance

The lack of maintenance is negatively related to individual happiness (Leyden, Goldberg, & Michelbach, 2011). People feel less safe, perceive the neighbourhood as being less green and have fewer social contacts when the maintenance of public space is lacking. Almost 70% of the elderly feel safer in a well-maintained neighbourhood (Kemperman & Timmermans, 2014). A lack of maintenance also affects people's residential satisfaction (Fernández-Carro, Módenes, & Spijker, 2015). In general, newly built neighbourhoods are better maintained, safer and have a higher quality. People who live in newly built neighbourhoods are found to be more satisfied with their residence and with their life. (Zhang, Zhou, & Kwan, 2019). A lack of maintenance also affects the interactions between people in public space (Ayala-Azcárraga, Diaz, & Zambrano, 2019). A decrease of social interactions due to lacking maintenance can lead to residents being at higher risk of feeling lonely (Nath, Han, & Lechner, 2018).

2.5.2. Parks and green areas

Distance to green areas and parks is related to life satisfaction. Larger distances to green areas negatively affect people's life satisfaction. The effect of distance to green spaces on life satisfaction is even stronger for ageing residents (Krekel, Kolbe, & Wüstemann, 2016) and for residents who live in high-density areas (Ambrey & Fleming, 2014). It has been argued that easy access to various types of green spaces, such as bushes, forests and natural reserves, results in higher life satisfaction of residents. Moreover, residents who are satisfied with the quality of green space are also more likely to be satisfied with their life (Fleming, Manning, & Ambrey, 2016).

Next to the influence of a short distance to green space on life satisfaction, it has been found that the accessibility of public space affects the social interactions between residents (Leyden, Goldberg, & Michelbach, 2011). Attractive public spaces provide opportunities for spontaneous social interactions (Kaczynski, Potwarka, & Saelens, 2008). Social opportunities, in turn, protect vulnerable residents from becoming lonely (Finlay & Kobayashi, 2018). In addition, people who frequently visit green spaces (van den Berg, et al., 2019) and people who live near green spaces (Maas, van Dillen, Verheij, & Groenewegen, 2009) are less likely to feel lonely.

2.5.3. Facilities and services

Local facilities, such as shops, schools, libraries and medical services should be accessible and well-maintained. When people are satisfied with the condition of these facilities, they are also more likely to be satisfied with their life (Fleming, Manning, & Ambrey, 2016). Improving the accessibility of the facilities and services improves people's life satisfaction (von Wirth, Grêt-Regamey, & Stauffacher, 2015). Fernández-Carro et al. (2015) argue that the accessibility of grocery stores, banking services and postal services is especially of importance for life satisfaction. For elderly specifically, being able to access facilities and services enables them to stay independent and to age in place (van Dijk, Cramm, van Exel, & Nieboer, 2015).

Social contacts between neighbours can take place at different locations, such as at recreational spaces, community facilities and shopping facilities. People who are satisfied with their social network, are more likely to be satisfied with the facilities in a neighbourhood. These residents are less vulnerable of feeling lonely (Kemperman, van den Berg, Weijs-Perrée, & Uijtdewillegen, 2019). For the elderly generation, it may be harder to make new social contacts in public space. Visiting community centres, book clubs, civic groups and other leisure facilities provide opportunities to meet neighbours and to avoid the risk of becoming lonely (Finlay & Kobayashi, 2018).

2.5.4. Incidents and crimes

As explained before, being able to access public space, particularly green space, affects the life satisfaction of people. However, if people are afraid of crimes in their neighbourhood, the effect of green space on life satisfaction disappears. People who are afraid of crimes less frequently visit public spaces than people who are not afraid (Fleming, Manning, & Ambrey, 2016). The chance of crimes in neighbourhoods where strong social connections between neighbours exist, is smaller than in neighbourhoods were social connections are weaker (Griffin, 2010). A stronger sense of community and less fear of crimes reduces feelings of loneliness (Prezza & Pacilli, 2007).

2.6. Subjective neighbourhood characteristics

Subjective neighbourhood characteristics are, amongst others, neighbourhood attachment (Clark, Duque-Calvache, & Palomares-Linares, 2015), social cohesion (Dassopoulos & Monnat, 2011) and the perception of walkability. This section explains these subjective neighbourhood characteristics.

2.6.1. Neighbourhood attachment

Neighbourhood attachment is caused by social relationships between family, friends and neighbours (Cantor, 1975). Recently, it has been shown that the intimacy of relationships with family and friends contributes to higher satisfaction with life (Brajša-Žganec, Merkaš, & Šverko, 2011). The presence of public spaces promotes social interactions between neighbours, inducing people to leave their homes. Feeling attached to the neighbourhood invites people to actively participate in public space, which leads to being more satisfied with life (Ayala-Azcárraga, Diaz, & Zambrano, 2019). Hadavi and Kaplan (2016) argue that the quality of public space should be increased to encourage outdoor community gatherings and socializing with neighbours. The addition of grass and trees in public space can promote social and physical participation in a neighbourhood (Kemperman & Timmermans, 2014). Moreover, people who are attached to their neighbourhood are less likely to feel less lonely (Weijs-Perrée, van den Berg, Arentze, & Kemperman, 2015).

2.6.2. Social cohesion

Social cohesion, measured as the contacts and emotional connections between neighbours, is another indicator of life satisfaction (Dassopoulos & Monnat, 2011). The effect of social cohesion on life satisfaction is the strongest for elderly (Delhey & Dragolov, 2016) and for vulnerable groups of people, such as people with mental problems (Ettema & Schekkerman, 2015).

In general, people who live in neighbourhoods with high levels of social cohesion report higher numbers of social interactions (Weijs-Perrée, van den Berg, Arentze, & Kemperman, 2015; van den Berg, Sharmeen, & Weijs-Perrée, 2017). People who have social interactions with others in the neighbourhood are less likely to feel lonely (van den Berg, et al., 2019). Especially among elderly, frequent contact with neighbours is of importance to prevent them from becoming lonely (Nyqvist, Victor, Forsman, & Cattan, 2016).

2.6.3. Perception of walkability

The walkability of a neighbourhood extends beyond the type of mobility or means of travel and does also include a type of sociability between neighbours (Moudon, et al., 2006). Walking fosters feelings of belonging and connection within the neighbourhood (Muir & McGrath, 2018). People who live in walkable neighbourhoods more often participate in events, know their neighbours better and are socially engaged. Their communal identity, or the extent to which residents perceive themselves as community members, mediates the effect between walkability and life satisfaction (Jaskiewicz & Besta, 2014).

People who change from using the car to walking experience a decrease in social isolation, stress and feelings of loneliness (Martin, Goryakin, & Suhrcke, 2014). People who walk and cycle frequently within the neighbourhood experience the quality of social interactions to be higher. People who live in neighbourhoods where social cohesion and walkability are high, have more social interactions. In general, social interactions are enhanced in green and walkable neighbourhoods (van den Berg, Sharmeen, & Weijs-Perrée, 2017). People who live in green neighbourhoods are also found to be less prone of feeling lonely (Maas, van Dillen, Verheij, & Groenewegen, 2009).

2.7. Conclusion

This chapter showed that personal characteristics, objective and subjective neighbourhood characteristics affect the extent to which neighbours feel lonely and satisfied with their life. Previous studies indicated that people who frequently visit public spaces are more likely to meet others and to have social interactions. These residents are more likely to be satisfied with their life and are less likely to be lonely. A relationship between loneliness and life satisfaction is also expected. The conceptual model of Figure 2.3 shows the expected relationships.

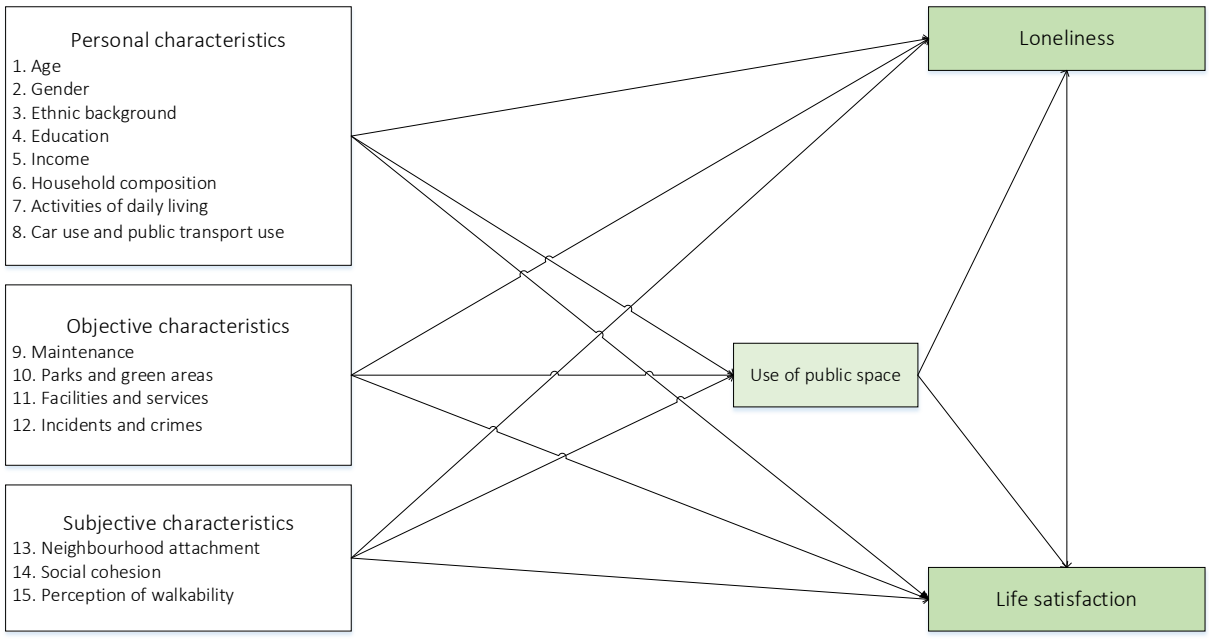

Figure 2.3: Conceptual model

3. Research method

In chapter 2, a literature review has been performed to define the conceptual model as is shown in Figure 2.3. This chapter will introduce the methodologies that are considered and the methodology that is chosen to study the relationships that are hypothesized in the conceptual model, as well as the research design and the data collection.

3.1. Methodology

The main objective of the current study is to gain insights in the use of public space, explained by personal and neighbourhood characteristics, as well as to gain insights into the characteristics that influence loneliness and life satisfaction. As previously explained, the available scientific evidence on this topic is limited. A literature review was therefore conducted to observe which relationships exist between personal and neighbourhood characteristics and public space use on the one hand and loneliness and life satisfaction on the other hand. The expected relationships were then schematically presented in the conceptual model. The conceptual model forms the basis for the next part of the research, in which a cross-sectional approach is used to collect data.

A cross-sectional approach is used to collect data at one point in time (Baarda, et al., 2012). An online questionnaire is composed, which is distributed among the target group of residents aged above 18 in three neighbourhoods of the middle-sized Dutch city 's-Hertogenbosch: Maaspoort, Binnenstad (inner city) and Rosmalen Zuid. To increase the response of the target group, the web-based questionnaire is distributed via social media as well as via meetings with community and elderly centres in the three neighbourhoods. The cloud-based service Maptionnaire is used to collect survey data as well as map-based data.

Maptionnaire can be used to build, publish and analyse map-based questionnaires (Kahila-Tani, Broberg, Kyttä, & Tyger, 2015). This tool is selected, since it allows participants to draw their residential location and public spaces of interest on a digital map. Other methodologies, such as cognitive mapping, in which participants are asked to draw maps of the exterior world (Lynch, 1960) as well as GPS tracking, sensor data and social media have also been considered. These methods did, however, not seem to be suitable for the aims of the current research.

Cognitive mapping is not appropriate, since mental maps do not provide complete representations of the physical environment but are simplifications (Lee, Hitchcock, & Lei, 2018). GPS tracking is rather new but may not be suitable for a mixed sample in which elderly participate (Chaix, et al., 2012). In addition, sensor data collects real-time data about physical quantities and can also be embedded in smartphones (Ang & Seng, 2016). However, in 's-Hertogenbosch, the number of sensors that measure physical quantities is still low and it is assumed that not all participants own a smartphone. Social media can also be used to collect data about frequency of visits to parks and other urban spaces. Geo-referenced photos from Panoramio and Flickr can, for instance, be used (Chen, et al., 2018). One of the main reasons why this method has not been chosen, is the limited number of photos on both websites (Alivand & Hochmair, 2017).

Data that are collected by Maptionnaire, can be analysed in the statistical package SPSS version 22 and map-based data can be analysed in the geographical software package QGIS version 2.18.19. In SPSS bivariate analyses are performed to observe which relationships of the conceptual model are significant. These significant relationships form the input for the path analysis that is performed in LISREL. To reduce the number of variables in the path analysis and to overcome the risk of overfitting the model, the relationships that are found to be insignificant, are removed from the path model. The backward stepwise process is repeated until an acceptable model fit is found and all insignificant relationships are removed from the model.

The advantage of using a path analysis over bivariate or regression analysis is that multiple, both direct and indirect relationships between independent and dependent variables can be tested simultaneously. Path analysis is a special case of structural equation modelling, in which only observed variables are used (van den Berg & Timmermans, 2015). The path model is estimated by using the statistical package LISREL version 8.54. LISREL is an acronym for Linear Structural Relations and is used to study causality between invariant parameters that are normally distributed. LISREL uses two methods to compute path coefficients between latent variables, namely ordinary least squares regression and covariance analysis. LISREL can be used to report the goodness-of-fit measures and the structural equations to determine the strength of paths between parameters (Westland, 2019).

3.2. Research design

This section describes how the characteristics in the conceptual model are operationalized, by translating them into measurable variables. The operationalization is performed to prepare the questionnaire that is used to collect data among residents of the three selected neighbourhoods. In Appendix B, the complete questionnaire is added.

Personal characteristics

The personal characteristics of a respondent form the first dimension of predicting variables. Some characteristics are not open for interpretation such as **age** and **gender**. Respondents are simply asked at the beginning of the questionnaire to fill in their gender (male/ female) and age. Age is divided in eight categories. Categories are used to protect the privacy of participants.

Participant are also asked to indicate their educational background, income and ethnic background. The question about **educational background** is related to the highest education that respondents finished with a certificate and can be answered with none, primary school, secondary school, 'mbo', 'hbo', 'university' or 'others'. The preceding names of these levels of education are included as well, to ensure respondents answer the question correctly. The net monthly **income** of individuals is divided in three categories, low income (less than €1200 net per month), moderate income (between €1200 and €2400 net per month) and high income (more than €2400 net per month). Ethnicity, or the **ethnic background** of respondents, can be divided into 'no migration background/ Dutch' or 'others', where respondents can fill in their country of birth.

Another personal characteristic which is included in the questionnaire, is the **household composition**. Household composition can be divided in 'one-person household', 'couple without children', 'couple with children' and 'single parent family' or 'other composition'.

Activities of daily living (ADL) can be measured by the Groningen Activity Restriction Scale (GARS), existing of eighteen activities that show the ability or inability of people to perform activities of daily living (Suurmeijer, et al., 1994). Table 3.1 summarizes the eighteen activities that are included in the questionnaire. Suurmeijer et al. (1994) published the GARS with five answer categories but merged them to four. The fifth category was hardly chosen and was therefore merged with the fourth answer category. Participants indicate for all activities whether they can perform them independently. These answers will be summed, resulting in scores ranging from 18 to 72. A score of 18 indicates respondents who are not disabled and a score of 72 represents respondents who are severely disabled.

Table 3.1: Scale items Activities of Daily Living (based on Suurmeijer et al., 1994)

Activities of Daily Living	
Wash face/ hands	Walk outdoors
Feed yourself	Wash/ dry body
Get around inside house	Prepare dinner
Get on/ off toilet	Go up/ down stairs
Prepare breakfast/ lunch	Wash/ iron clothes
Get in/ out of bed	Take care of feet/ toenails
Stand up from chair	Make beds
Do light cleaning	Do shopping
Dress yourself	Do heavy cleaning

The **frequency of use of transport modes** is included as another personal characteristic. This variable is operationalized by asking respondents how often they use each of the following transport modes on a seven-point scale, ranging from never to (almost) daily (Kemperman, van den Berg, Weijs-Perrée, & Uijtdewillegen, 2019). Table 3.2 shows the transport modes that were used in a previous study by Kemperman et al. (2019). In their research, the transport modes walking and cycling were also included. However, in the current study these modes of transport are included in the three activities of public space use, as will be explained later in this section. They are therefore not included in the variable frequency of use of transport modes.

Table 3.2: Items Frequency of use of transport modes (based on Kemperman et al., 2019)

Frequency of use of transport modes
Car as a passenger
Car as a driver
Bus
Train

Objective neighbourhood characteristics

Most of the objective characteristics that were discovered in the literature review are not included in the questionnaire to avoid the questionnaire from becoming too extensive. In the survey, a question is included that asks participants to indicate their residential location; Maaspoort, Binnenstad or Rosmalen Zuid. The residential neighbourhood can be linked to objective neighbourhood characteristics, to explain possible differences in the sample. Objective neighbourhood characteristics include maintenance, parks and green areas, facilities and services and criminality and incidents.

Data about **maintenance** is collected by the comparison of the quality of public space of the three neighbourhoods by a reference category. The CROW methodology uses image measures to describe public spaces on a five-point scale, ranging from A+ to D levels. In 's-Hertogenbosch, the B-level is the reference level.

The percentage of land covered by **parks and green areas** is based on data that are collected by the statistical organization CBS in the Netherlands (Centraal Bureau voor de Statistiek, 2008). This database consists of a categorization of different land uses and the percentage of land that is covered by each type. This categorization exists for each municipality in the Netherlands.

The number of and the distance to **facilities and services** is also based on statistical data, collected by CBS (Centraal Bureau voor de Statistiek, 2019). Data about facilities and services are measured on a yearly basis and exist for each neighbourhood in Dutch municipalities.

Finally, data about **criminality and incidents** are collected from the neighbourhood monitor (in Dutch 'buurtmonitor'). This monitor is composed by the municipality of 's-Hertogenbosch and exists of demographic information as well as neighbourhood information (Gemeente 's-Hertogenbosch, 2019). Eight topics are included in the monitor about criminality and incidents, namely the number of home burglaries, bicycle thefts, destruction, nuisance by youngsters, car break-ins, threat, burglaries in barns, garages and garden houses and mistreatment.

Subjective neighbourhood characteristics

Subjective neighbourhood characteristics include neighbourhood attachment, social cohesion and the perception of walkability. The first subjective neighbourhood variable that is introduced in the questionnaire is **neighbourhood attachment**. Six statements are considered, based on the Neighbourhood Attachment Scale. This scale comprises four aspects of bonds towards the neighbourhood and people in the neighbourhood. Two aspects determine respondents' desires to change or not to change their neighbourhood (Bonaiuto, Aiello, Perugini, Bonnes, & Ercolani, 1999).

Table 3.3 summarizes the six items of the neighbourhood attachment scale. Bonaiuto et al. (1999) used a four-item agreement-disagreement scale to measure neighbourhood attachment. In the current research, a five-item scale is used to be consistent with scales that are used for other variables. The item 'I would willingly leave this neighbourhood' will be recoded, to ensure that a high sum score on neighbourhood attachment indicates that participants are attached to their neighbourhood. After recoding, a sum score of the six items can be calculated. The sum score ranges from 6 to 30, where 6 indicates participants who are not attached and 30 indicates participants who are attached to their neighbourhood.

Table 3.3: Items Neighbourhood Attachment Scale (based on Bonaiuto et al., 1999)

Neighbourhood Attachment Scale
This is the ideal neighbourhood to live in.
This neighbourhood is part of me.
There are places in the neighbourhood to which I am emotionally attached.
It would be hard for me to leave this neighbourhood.
I would willingly leave this neighbourhood.
I would not willingly leave this neighbourhood for another.

Social cohesion can be measured by seven statements that are based on different dimensions of social cohesion, introduced by Frieling (2008). One item is related to 'cooperation in the development of welfare' on an individual level and two items are related to the neighbourhood level. The dimension 'solidarity' is based on two items, and 'the feeling of involvement' is measured by one item. According to Frieling (2008), social cohesion in a neighbourhood depends on the possibilities to meet in public space, the motivation to invest in social contacts and the easiness to make contact with neighbours. The seven items, as shown in Table 3.4, are measured on a five-point scale, ranging from almost never or no one to almost always, often or almost everyone.

Table 3.4: Items Social Cohesion Scale (based on Frieling, 2008)

Social cohesion index
How often, in the past six months, did you have a chat with someone from the neighbourhood?
If you are away from home, is there someone in your neighbourhood who looks after your house?
If something important happens in the neighbourhood or with a neighbour, is there someone in your neighbourhood who will make you aware of it?
Do you feel involved with the people who live in your neighbourhood?
If there is a sad moment or a sad event in your life, are there any residents who help and support you?
Are there any neighbourhood parties, barbecues or other activities in the neighbourhood, for which the whole neighbourhood is invited?
Have you collaborated with other residents to organize something in the neighbourhood in the past year?

Walkability is measured by the Neighbourhood Environment Walkability Scale, that exists of 39 statements, divided in several categories (Cerin, Saelens, Sallis, & Frank, 2006). For each of these categories one statement with the highest factor loading is chosen to measure walkability in the current study. Table 3.5 provides an overview of these items. Walkability is measured on a five-point scale, ranging from completely disagree to completely agree. A sum score will be calculated, that can range from 6 to 30. A score of 6 indicates participants who perceive walkability to be low in their neighbourhood, whereas a score of 30 indicates participants who perceive walkability to be high.

Table 3.5: Items Walkability Scale (based on Cerin et al., 2006)

Walkability
Stores are within easy walking distance at my home.
There are many alternative routes for getting from place to place in my neighbourhood.
The sidewalks in my neighbourhood are well maintained.
There are many attractive natural sights in my neighbourhood.
There is so much traffic along nearby streets that it makes it difficult or unpleasant to walk in my neighbourhood.
The crime rate in my neighbourhood makes it unsafe to go on walks at night.

Use of public space

The use of public space is measured by three activities to determine the patterns of outdoor space use. These activities are the **frequency of walking or cycling** in the neighbourhood for different purposes, the **frequency of use of specific public spaces** and the **frequency of specific activities** (Hadavi & Kaplan, 2016). The activities are measured on a seven-point scale, ranging from never to (almost) daily.

The categorization of frequency of use of specific public spaces is based on the ground statistics document of CBS (2006). The categorization is used since 1996 and exists of several categories that describe the land use in the Netherlands. In Appendix C, a description of the most occurring land uses in 's-Hertogenbosch is added. Table 3.6 shows the area of land that is covered by each land type in 's-Hertogenbosch (Centraal Bureau voor de Statistiek, 2018). In addition, Table 3.7 shows the categories that are used in the questionnaire to measure the three activities of public space use.

Table 3.6: Land use typology public space (based on CBS, 2008)

Public space typology 's-Hertogenbosch	Total area (ha)	Percentage of total area (%)
Park	359	3.0
Sport field	270	2.3
Community garden	18	0.2
Day recreational area	77	0.6
Agricultural area	5479	46.4
Forest	520	4.4
Total	11807	56.9

Table 3.7: Items use of public space (based on Hadavi & Kaplan, 2016)

Frequency of walking/ cycling	Frequency of use of specific spaces	Frequency of specific activities
For pleasure	Park	Outdoor sitting and watching
To visit someone	Sport field	Running
To visit green space	Community garden	Biking
To walk the dog	Day recreational area	Outdoor gathering
To make a purchase	Agricultural area	Picnicking
To get to bus stop	Forest	Walking
To go to restaurant	Another place	Gardening
To visit a place		Other activities

Loneliness

Loneliness is measured by using the three-item loneliness scale, developed by Hughes et al. (2004). Respondents can rate the three items using three response categories; 'hardly ever', 'some of the time' and 'often'. Table 3.8 shows the three categories of the loneliness scale. In the analysis, the sum score of the three items will be used to explain the effect of feelings of loneliness. The sum score ranges from 3 to 9, where a score of 3 indicates participants who are not lonely and 9 indicates participants who often feel lonely.

Table 3.8: Items loneliness (based on Hughes et al., 2004)

Loneliness
How often do you feel that you lack companionship?
How often do you feel left out?
How often do you feel isolated from others?

Life satisfaction

Life satisfaction is measured by the Satisfaction With Life Scale, which was developed by Diener et al. (1985). Diener et al. (1985) determined five statements to measure the satisfaction of people with their life, by asking participants to rate the statements on a seven-point scale, ranging from completely disagree to completely agree. In the current study, a five-point scale is used to be consistent with the scales that are used to measure other variables. Table 3.9 shows the five items of the scale that are used in this study. A sum score can be calculated, which ranges from 5 to 25. A score of 5 indicates participants who are not satisfied with their life, while a score of 25 indicates respondents who are very satisfied with their life.

Table 3.9: Items Satisfaction With Life Scale (based on Diener et al., 1985)

Life satisfaction
In most ways my life is close to ideal.
The conditions of my life are excellent.
I am satisfied with my life.
So far, I have gotten the important things I want in life.
If I could live my life over, I would change almost nothing.

3.3. Data collection

In section 3.2 the variables that are used to collect data in the questionnaire were operationalized. This section will first describe where data are collected, followed by a description of how these data are collected. Then, the internal and external reliability and validity will be discussed. This section ends with a description of approval of the ethics committee and the informed written consent.

3.3.1. Description of work field

The municipality of 's-Hertogenbosch is divided in fourteen neighbourhoods, that all have different physical and socio-demographic characteristics. Three neighbourhoods with varying characteristics are selected, namely Rosmalen Zuid, Maaspoort and Binnenstad. The locations of these neighbourhoods in 's-Hertogenbosch are indicated in Figure 3.1. This section describes the socio-demographics and physical characteristics of the three selected neighbourhoods.

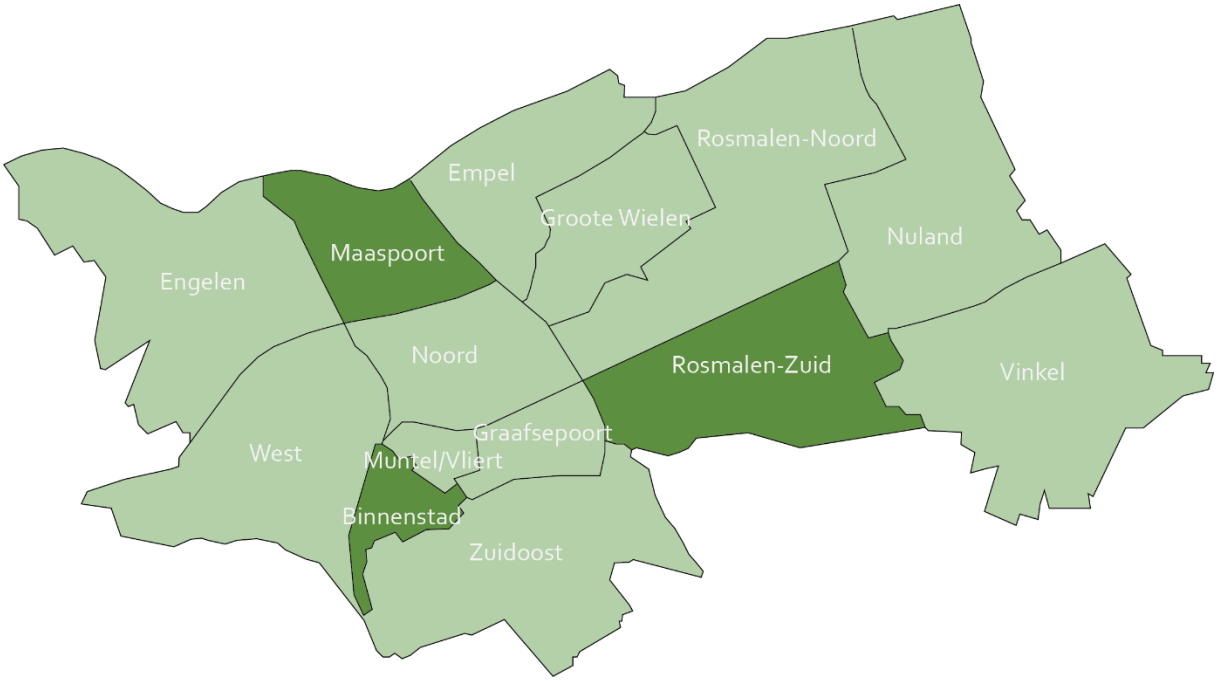

Figure 3.1: Selected neighbourhoods of 's-Hertogenbosch

Age

Table 3.10 shows the **age** distribution of the population in three selected neighbourhoods of 's-Hertogenbosch. Here, it can be observed that the percentage of children in Binnenstad is considerably lower than in Maaspoort and Rosmalen Zuid. The percentage of people aged between 20 and 29 is higher than in Maaspoort and Rosmalen Zuid. The distribution of the other age groups is comparable for the three neighbourhoods, with a somewhat higher percentage of elderly in Rosmalen Zuid. The age distribution of Maaspoort is most similar to the average in 's-Hertogenbosch.

Currently, more than 15% of the residents of Maaspoort are aged above 65, of which almost 5% are older than 75 (Gemeente 's-Hertogenbosch, 2019). It is expected that the percentage of people aged above 75 will increase to more than 6%. Together with the neighbourhoods Empel and Engelen, Maaspoort is one of the neighbourhoods that faces a rapid increase of the number of ageing residents. In Rosmalen Zuid the percentage of elderly is also high and is expected to increase further. In 2030, Rosmalen Zuid will be the neighbourhood with the highest percentage of ageing residents.

Table 3.10: Age distribution 's-Hertogenbosch (based on Gemeente 's-Hertogenbosch, 2019)

	Maaspoort (%)	Binnenstad (%)	Rosmalen Zuid (%)	's-Hertogenbosch (%)
Age				
0-19 years	22.5	9.9	22.6	21.4
20-29 years	10.1	26.5	7.0	13.2
30-39 years	12.2	15.6	10.2	13.4
40-49 years	14.3	11.8	12.6	13.9
50-59 years	18.2	13.1	15.3	14.4
60-69 years	13.3	11.3	15.9	11.9
70-79 years	7.0	7.1	10.3	7.7
80 years or older	2.4	4.7	6.1	4.1
Total (N)	16734	12840	9329	143452

Gender

Table 3.11 shows the **gender** distribution of Binnenstad, Rosmalen Zuid and Maaspoort. As is shown in this table, the distribution is almost the same for the three neighbourhoods. The distribution of males and females is almost 50% males and 50% females, as is also the case in the Netherlands and in 's-Hertogenbosch. Binnenstad and Rosmalen Zuid are inhabited by somewhat more females than Maaspoort.

Table 3.11: Gender distribution 's-Hertogenbosch (based on Gemeente 's-Hertogenbosch, 2019)

	Maaspoort (%)	Binnenstad (%)	Rosmalen Zuid (%)	's-Hertogenbosch (%)
Gender				
Male	50.3	49.3	49.5	49.4
Female	49.7	50.7	50.5	50.6

Ethnic background

Table 3.12 shows the **ethnic background** of residents of the three neighbourhoods of 's-Hertogenbosch. The table indicates that most residents do not have a migration background and are Dutch. In the inner city the percentage of Dutch residents is lower than in Rosmalen Zuid and Maaspoort. Here, the percentage of western immigrants is somewhat higher than on average in 's-Hertogenbosch and the percentage non-western immigrants is somewhat lower (Gemeente 's-Hertogenbosch, 2016).

Table 3.12: Ethnic background 's-Hertogenbosch (based on Gemeente 's-Hertogenbosch, 2019)

	Maaspoort (%)	Binnenstad (%)	Rosmalen Zuid (%)	's-Hertogenbosch (%)
Ethnic background				
Dutch	82.5	79.5	89.5	79.7
Non-western	7.6	8.9	3.0	11.4
Western	9.9	11.6	7.5	8.9

Household composition

Table 3.13 shows the **household compositions** in ‘s-Hertogenbosch, based on CBS (2018). The table shows that the percentage of one-person households is considerably higher in Binnenstad than in Rosmalen Zuid and Maaspoort and in ‘s-Hertogenbosch on average. The percentage of one-person households in the inner city is expected to increase. A considerable percentage of these one-person households exist of residents who are aged 75 or above (Gemeente 's-Hertogenbosch, 2014).

Table 3.13: Household composition ‘s-Hertogenbosch (based on CBS, 2018)

	Maaspoort (%)	Binnenstad (%)	Rosmalen Zuid (%)	‘s-Hertogenbosch (%)
Household composition				
One-person household	28.0	63.2	25.6	39.7
Household without children	32.2	26.0	36.1	28.7
Household with children	39.8	10.8	38.3	31.6
Total (N)	7200	8280	3645	72077

Maintenance

Table 3.14 shows the scale scores of **maintenance** in the three neighbourhoods of ‘s-Hertogenbosch. These scores are based on the two-yearly customer satisfaction research which is performed in ‘s-Hertogenbosch (Gemeente 's-Hertogenbosch, 2018). Scores can range from 1 to 10, where 1 indicates places that are not well-maintained and 10 indicates places that are well-maintained. The research of 2017 shows that the average score of Binnenstad is the highest, meaning that the overall maintenance of Binnenstad is most positively experienced. For the sub-scores, the maintenance of green in Rosmalen Zuid is lacking. The scores for the maintenance of roads and street furniture are also lacking compared to the other two neighbourhoods and to the average of ‘s-Hertogenbosch.

Table 3.14: Scale scores Maintenance (based on KTO Gemeente ‘s-Hertogenbosch, 2018)

	Maaspoort	Binnenstad	Rosmalen Zuid	‘s-Hertogenbosch
Maintenance				
Cleanliness nearby living environment	6,8	7,1	6,6	6,6
Maintenance green	7,8	8,2	6,5	7,5
Maintenance roads	7,3	7,7	7,0	7,3
Maintenance street furniture	7,0	7,3	6,7	7,1
Maintenance facilities youth	7,3	7,0	7,7	7,4
Safety facilities youth	7,7	7,1	8,1	7,6
Average	7,3	7,4	7,1	7,3

Parks and green areas

‘s-Hertogenbosch is covered by many **parks and green areas**, such as the Zuiderpark, Oosterplas and the Bossche Broek, Table 3.15 shows the percentage of land covered with parks, sport fields, community gardens, day recreational area, agricultural area and forest, based on CBS (2015). It is shown that the total recreational area in Binnenstad is lower than in other neighbourhoods and in ‘s-Hertogenbosch. The land covered with parks, sport fields, community gardens, day recreational area, agricultural area and forest is also lower in the inner city. In Maaspoort, the total recreational area is quite high, compared to ‘s-Hertogenbosch. In Maaspoort relatively many sport facilities are located, such as Maaspoort Sports & Events, de Plek/ Flik Flak and Tennis & Padel Club Maaspoort. This neighbourhood is also characterized by large public spaces, such as the Burgemeester van Zwietenpark and Maasoevers (Gemeente 's-Hertogenbosch , 2018).

Table 3.15: Parks and green areas ‘s-Hertogenbosch (based on CBS, 2015)

	Maaspoort (%)	Binnenstad (%)	Rosmalen Zuid (%)	's-Hertogenbosch (%)
Parks and green areas				
Park	9.6	0.8	1.0	3.0
Sport field	2.7	0.0	1.5	2.3
Community garden	0.2	0.0	0.1	0.2
Day recreational area	0.4	0.0	2.9	0.7
Agricultural area	17.2	5.9	31.1	46.4
Forest	0.5	0.4	20.9	4.4
Total area (ha)	565	236	1043	11807

Facilities and services

Every year, CBS (2019) measures the distance and the number of **facilities and services** in Dutch municipalities on a neighbourhood level. Table 3.16 shows the distance to and the number of facilities and services, such as health services, retail and cafés and restaurants. Big supermarkets refer to supermarkets with a minimal surface of 150 square meters. Shops with other daily needs are for instance a bakery, coffee/tea shop, a butcher or a liquor store.

As is shown in Table 3.16, the distance to supermarkets, shops with other daily needs, cafés and restaurants is the lowest in Binnenstad and is somewhat higher in Rosmalen Zuid than the average of ‘s-Hertogenbosch. The number of facilities and services, such as big supermarkets, cafés, restaurants, and shops with other daily needs is, as expected, higher in the inner city than on average in ‘s-Hertogenbosch. The distance to train stations is the highest in Maaspoort, since Rosmalen Zuid has its own train station and Binnenstad is close to the central station of ‘s-Hertogenbosch.

Table 3.16: Facilities and services (based on CBS, 2019)

	Maaspoort	Binnenstad	Rosmalen Zuid	's-Hertogenbosch
Facilities and services				
Health and well being				
Distance to hospital (km)	1.9	2.5	1.5	2.8
Within 5 km (nr.)	1.0	1.7	1.1	1.3
Retail				
Distance to big supermarket (km)	0.7	0.4	1.3	0.7
Within 1 km (nr.)	1.3	3.2	0.8	1.7
Within 3 km (nr.)	6.3	16.8	3.8	9.1
Distance to shops with other daily needs (km)	0.7	0.2	1.0	0.7
Within 1 km (nr.)	3.0	43.3	3.3	7.7
Within 3 km (nr.)	13.4	84.1	17.5	39.1
Restaurants and cafés				
Distance to café (km)	1.9	0.3	1.3	1.1
Within 1 km (nr.)	0.2	32.0	0.4	4.6
Within 3 km (nr.)	1.4	60.3	5.1	23.4
Distance to restaurant (km)	0.7	0.2	0.9	0.7
Within 1 km (nr.)	1.2	96.8	1.9	12.2
Within 3 km (nr.)	8.3	163.2	14.8	64.0
Transport				
Distance to train station (km)	4.3	1.1	1.8	2.7

Criminality and incidents

Table 3.17 shows the total number of **crimes and incidents** in 's-Hertogenbosch and in the three selected neighbourhoods. Crimes and incidents are categorized according to the neighbourhood monitor (Dutch 'buurtmonitor') of 's-Hertogenbosch (Gemeente 's-Hertogenbosch, 2019).

The total number of crimes and incidents is the highest for Binnenstad, where the percentage of bicycle thefts is relatively high compared to Rosmalen Zuid and Maaspoort. The municipality explains this by the argument that the concentration of people in a relatively small area with a larger variety of services and facilities leads to more incidents, crimes and nuisance (Gemeente 's-Hertogenbosch, 2016).

Table 3.17: Criminality and incidents (based on Gemeente 's-Hertogenbosch, 2019)

	Maaspoort (%)	Binnenstad (%)	Rosmalen Zuid (%)	's-Hertogenbosch (%)
Criminality and incidents				
Home burglary	13.2	2.4	7.5	6.4
Bicycle theft	5.0	27.3	8.1	13.8
Destruction	11.8	8.4	10.5	11.8
Nuisance by youngsters	20.1	6.5	11.5	10.8
Car burglary	20.5	17.5	28.5	20.8
Threat	3.5	5.1	5.4	4.5
Burglary in garden/ shed	3.1	1.4	2.7	3.5
Mistreatment	22.7	31.4	25.8	28.5
Total	576	1904	295	8921

3.3.2. Distribution procedure

Previously, the operationalization of characteristics into measurable variables and the three neighbourhoods in which the questionnaire is distributed, have been introduced. This section describes the distribution procedure.

Distribution via social media

The distribution of the questionnaire via social media is two-fold. The author of the research distributed the survey via personal social media channels, such as Facebook, LinkedIn and Instagram. To increase the response rate of the survey and to obtain a large sample, owners of social media webpages were also contacted. Again, channels such as Facebook and Instagram were used. In Appendix D the webpages that were used, are summed.

Distribution via community centres and elderly centres

Next to the distribution via social media, the questionnaire is distributed via community centres and elderly centres. Table 3.18 shows the meetings that were arranged with community centres and elderly centres to assist residents and visitors in filling in the questionnaire. These centres were visited to obtain a mixed sample of active participants, participants with health issues and participants of different ages. The colours in Table 3.18 indicate the neighbourhoods in which the centres are located (yellow for Rosmalen Zuid, blue for Binnenstad and pink for Maaspoort). Two weeks of June were selected to visit the centres. Flyers were made to distribute the questionnaire at community centres, libraries and cafés. The layout of the flyer is added to Appendix E.

Table 3.18: Overview of information meetings

	Mon 10-6	Tue 11-6	Wed 12-6	Thu 13-6	Fri 14-6
9.00					
10.00			De Slinger 10.00-12.00		
11.00					
12.00					
13.00			Epigoon 12.15		
14.00				Annenborch 14.00	
15.00					
16.00					
17.00					

	Mon 17-6	Tue 18-6	Wed 19-6	Thu 20-6	Fri 21-6
9.00					
10.00	Bij Katrien 9.30-12.00	Bij Katrien 9.30-12.00	Bij Katrien 9.30-12.00		
11.00					
12.00			Ouderen voor Ouderen 12.00-12.30		
13.00		OSM Soosmiddag 13.00-14.00			
14.00				Annenborch 14.00	
15.00					
16.00					
17.00					

Procedure

Data were collected in the months June and July 2019. The responses of the questionnaire are analysed to gain insights in the significance of relationships between the variables that were described in previous sections and shown in the conceptual model. Reliable analyses can be performed when the sample size of the model is at least ten times as big as the number of parameters in a model (Kline, 1998). As was shown in the conceptual model, the number of variables in this study equals 18, meaning that the sample size should at least be 180. The aim of the study was to gain at least 180 responses, preferably 60 respondents per neighbourhood. A mix in socio-demographics in the sample was also preferred, existing of a mix of age, gender, ethnic background, educational background, income and household composition.

3.3.3. Data reliability & validity

Reliability

The reliability of the research can be observed by the consistency or stability of results over time and by the replicability of results under a similar methodology (Golafshani, 2003). Research methods are more reliable when they are independent of coincidences and random errors. The reliability of research is easily influenced by the environment in which the respondent behaves and by the mood of the individual (Baarda, et al., 2012). To minimize the effect of the environment, respondents are asked to fill in the questionnaire at home or are helped to fill it in during appointments with community and elderly centres. During these meetings, responses of individuals should not be influenced by other participants nor by the researcher.

The formulation of interview questions can also influence the reliability of the information. Therefore, the following aspects should be considered (Baarda, et al., 2012):

Questions and answer categories should be clear and unambiguous.
Avoid two or more questions in one question.
Avoid the use of professional jargon and difficult formulation of questions.
Avoid suggestive questions.
Avoid the assumption that respondents have specific knowledge.

In addition to the questions, the answer categories should be unambiguous and should exclude each other. For ordinal, interval or ratio scales answer scales can be used, which typically include three or five items. For some questions, such as questions that ask about specific knowledge, a 'I don't know' or 'unknown' answer category can be included in research (Baarda, et al., 2012).

Internal validity

Next to the reliability of the study, the results should also be valid. Research is valid when the intended target is measured by the study. Internal validity, or criterion validity, considers whether the instrument measures exactly what it claims to measure. The content validity, or the representation of the construct by individual items of a questionnaire should, in addition, be tested (Field, 2009). Research to the validity of items of a questionnaire can be done by searching for items that measure the intended target of the study and then using a correlation measure to determine the relation between the items (Baarda, et al., 2012). Existing constructs and items that have previously been described and tested, can be used for the operationalization of variables to realize internal validity of the study.

In the current study, internal validity is realized by including questions that are understandable, specific and that cover the complex concepts to the fullest (Baarda, et al., 2012). Still, there is a chance of misinterpretation of questions or answer categories. It may be difficult for respondents to understand or read maps, which can lead to wrong placement of often used facilities or routes throughout the neighbourhood. These risks should be solved to guarantee internal validity of the study. The difficulty of the questions and answer categories can be tested by using more general questions that serve as criteria for the validation investigation. In addition, some individuals (not necessarily of the sample) can be asked to do a pre-test, to test whether the questionnaire is understandable. The questionnaire can partly be changed when the pre-test shows that respondents do not fully understand the questions. A second pre-test can be done to test whether the changed questionnaire results in more understanding.

External validity

The external validity of the study should also be investigated. External validity, or ecological validity, relates to the generalizability and applicability of the study results in real world situations (Field, 2009). In experimental research, one of the variables is manipulated to observe the effect on a second variable. In correlational research, as will be used in the current study, variables are not influenced individually, but observations show real world results of the relationship between variables. Current research aims to provide research results that are applicable to real world situations.

Next to applicability to real world situations, the research methodology should be generalizable. Due to careful selection of the sample and aiming for a random sample, results are expected to be generalizable to the rest of 's-Hertogenbosch and eventually to the rest of the Netherlands. People in all three neighbourhoods have equal chances of participating in the questionnaire, since the distribution of the questionnaire is two-fold. Using both social media as well as making appointments with community and elderly centres, increases the chance of a large variety of participants to respond to the questionnaire.

3.3.4. Informed written consent

Data that are retrieved by the questionnaire contain privacy sensitive information. The personal questions in which respondents are asked to indicate their age and their yearly income are private and can only be collected when respondents give permission. Map-based questions that ask participants to draw their residential location as well as routes and frequently visited places on a digital map will inevitably provide information about the residences of participants. The aggregation level should be of a lower detail, for instance a street-level instead of a residence-level, to assure that respondents are untraceable.

The collected data will be pseudonymized, meaning that personal data will not be traceable to the individual. Direct identifiable information of an individual will be deleted, and responses of individuals will be categorized and stored in separate files. The drawn routes on maps will be combined in the geographical system QGIS, containing aggregated data. This makes identification of individual respondents impossible. The identification key to individual responses will be stored in an encrypted file and will be stored separately on a location that is only accessible by the researcher. The individual data will be aggregated to the level of anonymous socio-demographic groups as soon as possible and afterwards the separate datasets will be deleted.

Respondents will be informed about the purpose of the research and will, by participating to the survey, agree with the information and the aim of the research. Participation is voluntary and transparency to respondents is guaranteed by the information consent that is added to the questionnaire. Appendix F shows the Dutch version of the consent.

3.4. Conclusion

This chapter consisted of three parts; the methodology, the research design and the data collection. The first part described that data are collected by using a cross-sectional approach. In the second section, it was explained that data are retrieved in three neighbourhoods of the middle-sized Dutch city ‘s-Hertogenbosch. The characteristics of these neighbourhoods, Maaspoort, Binnenstad and Rosmalen Zuid were described in this section. The third section described the data collection methodology. In this section, it was explained that data are collected by distributing the questionnaire among residents of the three neighbourhoods via social media and via meetings with community centres. Data that are retrieved will be described in the next chapter.

4. Data description

In previous chapters the expected relationships were shown in the conceptual model, followed by the operationalization of the variables. Then, the methodology to collect data and the three neighbourhoods in which data were collected, were described. In this chapter the distribution of the collected data will be discussed. This chapter provides insights into the characteristics of the sample, which can be used to test relationships that are expected between personal and subjective neighbourhood characteristics, use of public space, loneliness and life satisfaction.

4.1. Sample description

As has previously been described, the sample of the study should, ideally, be equally divided among the three selected neighbourhoods and should be mixed in socio-demographics. However, due to the possibility to fill in the questionnaire online, a perfect distribution among the three neighbourhoods could not be achieved. In total, 297 participants responded to the questionnaire, of which 200 participants indicated their residential neighbourhood. 97 responses were deleted to be able to use the same sample for all analyses.

4.2. Personal characteristics

This section presents the distribution of the personal characteristics of the sample. Table 4.1 shows the personal characteristics of the participants after recoding the answer categories. Data are compared to nationwide averages, measured by CBS (2019) and to city specific data of 's-Hertogenbosch, which are measured by the municipality of 's-Hertogenbosch (2019).

Table 4.1: Demographics of sample

	Sample (%)	's-Hertogenbosch (%)	Netherlands (%)
Age			
18-35 years	25.5	25.5	24.3
36-55 years	27.5	35.3	33.8
56 years or older	47.0	39.2	41.9
Total	100	100	100
Gender			
Male	27.5	49.0	49.7
Female	72.5	51.0	50.3
Total	100	100	100
Education			
Low	20.5	28.0	31.1
Moderate	24.5	37.5	37.8
High	55.0	34.5	31.1
Total	100	100	100
Income			
Low (lower than €1200 net/ month)	22.5	-	-
Moderate (€1200-€2400 net/month)	41.5	-	-
High (higher than €2400 net/month)	29.5	-	-
Unknown	6.5	-	-
Total	100	-	-
Ethnicity			
Dutch	98.0	79.7	76.9
Others	2.0	20.3	23.1
Total	100	100	100
Household composition			
One-person household	28.0	38.1	39.7
Household without children	36.0	28.8	28.7
Household with children	36.0	33.0	31.6
Total	100	100	100

Age

Age was the first closed question of the questionnaire and is answered by all 200 respondents. The age groups '18-25 years old' and '26 to 35 years' are merged into the youngest age group. Subsequently, the age groups '36 to 45 years old' and '46 to 55 years old' are merged into the middle age group. Finally, the answer categories '56-65 years old', '66-75 years old', '76-85 years old' and '86 years or older' are merged into the category '56 years or older', since the frequencies of these age groups were low. Compared to the age distribution of the population in 's-Hertogenbosch and in the Netherlands, the oldest age group (47.0%) is somewhat overrepresented in the sample, whereas the other age groups are comparable or underrepresented.

A one-sample Chi-Square test is conducted to observe whether the differences in distribution of age are statistically significant at the 0.05 level. A p-value of 0.038 was found for the comparison with the 's-Hertogenbosch population, which means that there are significant differences between the age distribution of the sample and the population of 's-Hertogenbosch. For the comparison between the distribution of the sample and the Netherlands, a p-value of 0.157 is observed, meaning that there are no significant differences between the age distribution of the sample and the population of the Netherlands. Therefore, the representativeness of the sample is acceptable. Due to the non-random method to select the sample -visiting social centres and elderly care centres- overrepresentation and underrepresentation occurs.

Gender

The second variable, gender, is answered by all 200 respondents of the questionnaire. No further recoding of the answer categories was necessary. Table 4.1 shows that the sample contains more female respondents (72.5%) than male respondents (27.5%). This may be caused by the amount of time people spend at home, which may traditionally be more for females than for males. A one-sample Chi-Square test is conducted to test whether the distribution of the sample differs significantly from the distribution in 's-Hertogenbosch and the Netherlands. The Chi-Square tests shows that the distribution of gender differs significantly from the distribution in the Netherlands and in 's-Hertogenbosch. The representativeness of the variable gender is therefore arguable.

Education

In the questionnaire seven categories were included for the variable education. These answer categories are merged and recoded into three answer categories; low, moderate and high education. The categories 'others', 'university' and 'Hbo' are merged and recoded into high education. Others is included here, since most respondents indicated to have a Hbo certificate or higher. The moderate category exists of 'Mbo'. 'None', 'primary school' and 'secondary school' are merged and recoded in the category low education. CBS (2019) and 's-Hertogenbosch Magazine (2019) merged people who studied HAVO or VWO for three years or less into the low category and people who finished HAVO or VWO into the middle category. Since this deviation was not made in the questionnaire, all respondents who indicated to have finished secondary school are merged into the low category. The comparability of population data and sample data is therefore not optimal.

In the sample highly educated respondents are overrepresented (55.1%), whereas the other two categories are underrepresented. A one-sample Chi-Square test is performed to test whether the differences in distribution between the sample and the Netherlands and 's-Hertogenbosch are significant. Both Chi-Square tests show that the distribution of the sample is not similar to the distribution of the Netherlands or of 's-Hertogenbosch. The overrepresentation of people with a high educational background may be caused by the willingness of respondents to participate in the study.

Income

Income is divided in four answer categories, of which the fourth category is the 'unknown' answer. Two respondents did not answer the question. These cases are replaced by the mean value of the variable. Most respondents answered to have a moderate income (between €1200 and €2400 net per month), which is based on the net modal month income of €2120 in the Netherlands. Since both CBS and municipal statistics measure income on a household level, a comparison of the distribution between the sample and the population could not be made.

Ethnic background

Table 4.1 shows that almost all respondents of the questionnaire are Dutch. Only four respondents filled in that they were born in another country, namely in Germany, Colombia and Belgium. One respondent answered to be born in another country but did not fill in the country. The comparison with 's-Hertogenbosch and the Netherlands (Centraal Bureau voor de Statistiek, 2019) shows that the sample is not representative of the population. Due to a lack of variety in ethnicity, this variable will be deleted from further analyses.

Household composition

In the questionnaire, household composition was divided in five answer categories; 'one-person households', 'couple without children', 'couple with children', 'single parent family' and 'other compositions'. CBS (2019) divides the population in three compositions: one-person households, households without children and households with children. To compare the sample data with the population, categories are recoded. 'Single parent families' are merged with the 'couple with children' category into 'households with children'. The 'one-person household' and 'couple without children' remain unchanged.

Table 4.1 shows that one-person households are underrepresented in the sample compared to the Netherlands and 's-Hertogenbosch. Two one-sample Chi-Square tests are performed to test whether the differences in distribution between the sample and the population are significant. The tests show that the distribution of the sample is not similar to the distribution of the population in the Netherlands or in 's-Hertogenbosch, meaning that the sample is not representative for the population.

Activities of daily living

The Groningen Activity Restriction Scale (GARS) is used to measure the daily activities of respondents, existing of four answer categories and eighteen activities (Suurmeijer, et al., 1994). Table 4.2 shows the frequencies of the daily activities. This table shows that there are some activities respondents have difficulties with, such as going up and down the stairs, washing and ironing clothes, taking care of feet and toenails, making beds and doing heavy cleaning. Seven respondents did not fill in all items of the scale and two respondents only filled in one item. The missing cases are therefore replaced by the mean values.

After replacement of the missing values, the Cronbach's Alpha (α) is calculated to measure the consistency of the variable. Cronbach's Alpha is used to understand the internal consistency of concepts. Acceptable values of Cronbach's Alpha lie between 0.7 and 0.9. Lower values can be caused by a low number of questions, poor inter-relatedness between items or heterogeneous constructs (Tavakol & Dennick, 2011). Table 4.3 shows that Alpha equals 0.955, which is high. Deleting the items wash face/ hands and feed yourself would increase Alpha further. Since Alpha is already high with these items included, no items are deleted from the scale and a sum score can be calculated.

Table 4.2: Activities of daily living

	Yes, fully independently without difficulty (%)	Yes, fully independently with some difficulty (%)	Yes, fully independently with great difficulty (%)	No, not independently, need someone's help (%)	*Total (%)*
Activities of daily living					
Dress yourself	92.5	5.5	0.0	2.0	100
Wash face/ hands	97.0	2.5	0.0	0.5	100
Get around inside house	93.0	3.5	2.5	1.0	100
Prepare breakfast/ lunch	94.5	3.5	0.5	1.5	100
Get on/ off toilet	97.5	1.0	0.5	1.0	100
Stand up from chair	90.5	8.0	0.0	1.5	100
Do light cleaning	85.5	9.0	2.0	3.5	100
Walk outdoors	87.5	4.5	4.0	4.0	100
Wash/ dry body	90.0	7.0	0.5	2.5	100
Prepare dinner	86.5	5.5	1.5	6.5	100
Go up/ down stairs	82.5	8.5	3.5	5.5	100
Wash/ iron clothes	83.0	9.0	1.5	6.0	100
Take care of feet/ toenails	80.5	7.0	4.0	8.5	100
Make beds	83.5	5.5	3.0	8.0	100
Do shopping	85.0	6.0	2.0	6.5	100
Do heavy cleaning	76.5	8.0	2.0	13.5	100
Get in/ out of bed	92.0	5.5	1.0	1.5	100
Feed yourself	95.5	2.5	1.0	1.0	100

Table 4.3: Cronbach's Alpha Activities of daily living

Activities of daily living						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
18	72	21.88	79.477	8.915	18	0.955

The sum score varies between 18 (not disabled) and 72 (severely disabled). The mean of the sum score equals 21.88. Overall, respondents are not disabled and are not restricted in their daily activities. The histogram of Figure 4.1 is positively skewed, which supports the finding that most respondents can perform daily activities without any help.

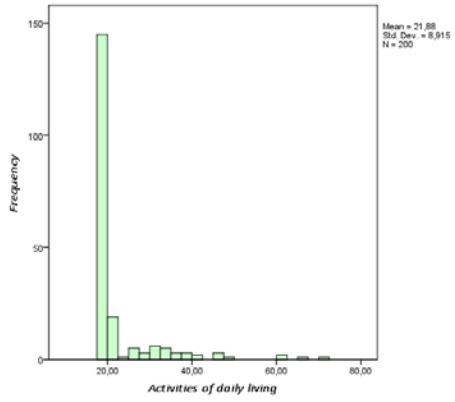

Figure 4.1: Histogram sum score activities of daily living

Frequency of car use

Frequency of car use exists of the items 'car use as a passenger' and 'car use as a driver', as is shown in Table 4.4. Most respondents indicated to use the car as a passenger and as a driver more than two times per week. 25 Respondents did not fill in one item or both items of car use. These missing values are replaced by the mean values.

Table 4.4: Frequency of car use

	Never (%)	Less than once per month (%)	Once per month (%)	2 or 3 times per month (%)	Once per week (%)	2 to 5 times per week (%)	(Almost) daily (%)	*Total (%)*
Frequency of car use								
Car as driver	15.0	2.5	1.0	2.0	15.5	31.0	33.0	100
Car as passenger	10.0	16.5	5.5	16.5	15.5	27.5	8.5	100

Frequency of public transport use

The frequency of public transport use is also included as a personal characteristic. In 's-Hertogenbosch, public transport exists of buses and trains. Table 4.5 shows the frequency of use of both transport modes. As is shown in this table, most respondents use public transport less than once per month or never. 21 respondents did not respond to one or both items of public transport use. These missing values are replaced by the mean values of the items.

Table 4.5: Frequency of public transport use

	Never (%)	Less than once per month (%)	Once per month (%)	2 or 3 times per month (%)	Once per week (%)	2 to 5 times per week (%)	(Almost) daily (%)	*Total (%)*
Frequency of public transport use								
Bus	41.5	39.5	4.0	4.5	2.0	6.5	2.0	100
Train	29.5	48.0	6.0	3.5	3.0	5.5	4.5	100

4.3. Objective characteristics

The objective variable that will be used in further analysis is the neighbourhood in which respondents indicated to live. 53% of the respondents indicated to live in Maaspoort, 21% in Binnenstad and 26% in Rosmalen Zuid. The pie chart of Figure 4.2 shows the distribution of respondents over the three neighbourhoods.

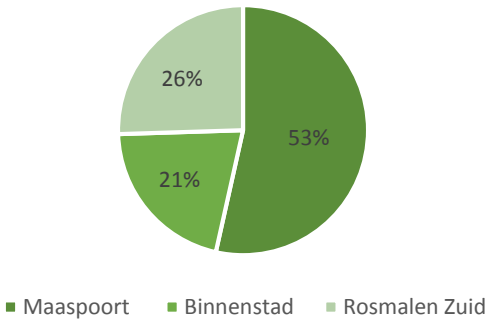

Figure 4.2: Pie chart neighbourhoods

4.4. Subjective neighbourhood characteristics

After the description of the personal characteristics and objective neighbourhood characteristics, a description of the subjective neighbourhood characteristics follows in this section. Firstly, the variable neighbourhood attachment will be described, followed by a description of the variables social cohesion and the perception of walkability.

Neighbourhood attachment

The Neighbourhood Attachment Scale (NAS) exists of several aspects of people's willingness to change their residential place, their bonds toward their neighbourhood and the extent to which the neighbourhood influences their identity (Bonaiuto, Aiello, Perugini, Bonnes, & Ercolani, 1999). Table 4.6 shows the items of the scale, of which the item 'I would willingly leave this neighbourhood' is a revere-score item. This item should be recoded before calculating the sum score. Seven respondents did not fill in all items of the scale and two respondents only filled in one item of the scale. Therefore, missing cases are replaced by the mean value. Table 4.6 shows that most respondents are somewhat attached to their neighbourhood.

Table 4.6: Neighbourhood attachment

	Completely disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Completely agree (%)	*Total (%)*
Neighbourhood attachment						
Ideal neighbourhood	2.5	8.0	19.5	49.5	20.5	100
Part of me	2.0	13.5	38.5	36.5	9.5	100
Attached to	11.0	30.5	29.5	22.0	7.0	100
Hard to leave	8.0	28.0	24.0	28.5	11.5	100
Willingly leave (reversed)	7.5	29.0	31.5	20.0	12.0	100
Not willingly leave	13.0	28.5	33.0	15.0	10.5	100

To check the reliability of the neighbourhood attachment scale, Cronbach's Alpha is calculated. Table 4.7 shows that Alpha equals 0.848 and does not increase when an item is deleted from the scale. Therefore, the scale is reliable, and a sum score can be calculated. The sum score varies between 6 and 30. Here, 6 indicates respondents who are not attached, while 30 indicates respondents who are attached to their neighbourhood. The mean of the sum score equals 18.87 and Figure 4.3 shows the histogram of neighbourhood attachment.

Table 4.7: Cronbach's Alpha Neighbourhood Attachment

Neighbourhood attachment						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
6	30	18.873	23.550	4.853	6	0.848

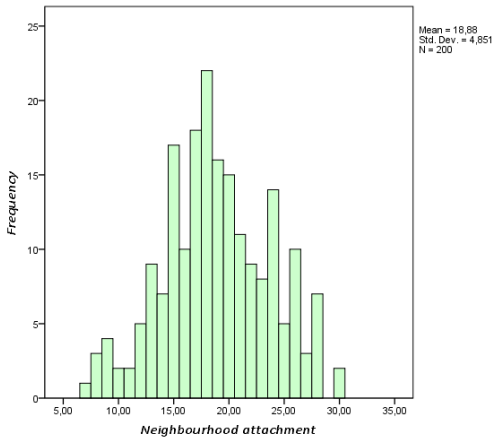

Figure 4.3: Histogram sum score neighbourhood attachment

Social cohesion

Social cohesion can be defined by the joint production, the degree of solidarity and the feelings of involvement (Frieling, 2008). Tables 4.8 to 4.11 show the distribution of the sample for social cohesion. Table 4.8 shows that most respondents chat with their neighbours a few times per week or more often. Table 4.9 shows that people sometimes or usually support neighbours when sad events occur or notify each other when something happens in the neighbourhood. Most respondents almost never attend barbecues, almost always keep an eye on their neighbours' houses, feel involved with some of their neighbours and almost never collaborate to organize parties or other events.

Four respondents did not answer all items of the social cohesion scale. Since all items of the social cohesion scale have different answer categories, missing values are replaced by the mean value. After replacement of the missing values, Cronbach's Alpha is calculated for the social cohesion scale to test the reliability of the scale. Alpha equals 0.742 and does not increase when an item is deleted from the scale, which is shown in Table 4.12. The reliability of the variable social cohesion is acceptable, and a sum score can be calculated. The sum score varies from 7 to 32, with a mean value of 22.29. Figure 4.4 shows the histogram of social cohesion.

Table 4.8: Social cohesion: Chatting with neighbours

	Frequency (N)	Percent (%)
Social cohesion: chat with neighbour		
Once per year or less often	3	1.5
A few times per year	15	7.5
A few times per month	34	17.0
Once per week	38	19.0
A few times per week or more often	110	55.0
Total	200	100

Table 4.9: Social cohesion

	(Almost) never (%)	Usually not (%)	Sometimes (%)	Usually (%)	(Almost) always (%)	*Total (%)*
Social cohesion						
Keep an eye on	5.5	5.0	8.0	30.0	51.5	100
Notify by neighbour	8.5	8.0	22.0	34.0	27.5	100
Sad event	14.0	11.5	19.5	26.5	28.5	100
Barbecues or neighbourhood parties	43.0	13.5	21.0	11.5	11.0	100

Table 4.10: Social cohesion: Involved with neighbours

	Frequency (N)	Percent (%)
Social cohesion: involved with neighbours		
With almost no one	13	6.5
With most people not	27	13.5
With some people	94	47.0
With most people	55	27.5
With almost everyone	11	5.5
Total	200	100.0

Table 4.11: Social cohesion: Collaborated with neighbours

	Frequency (N)	Percent (%)
Social cohesion: collaborated with neighbours		
No collaboration	151	75.5
Once in half a year or less often	17.0	17.0
Once in three months	3.5	3.5
Once in two months	1.5	1.5
Monthly or more often	2.5	2.5
Total	200	100.0

Table 4.12: Cronbach's Alpha Social cohesion

Social cohesion						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
7	35	22.289	25.586	5.058	7	0.742

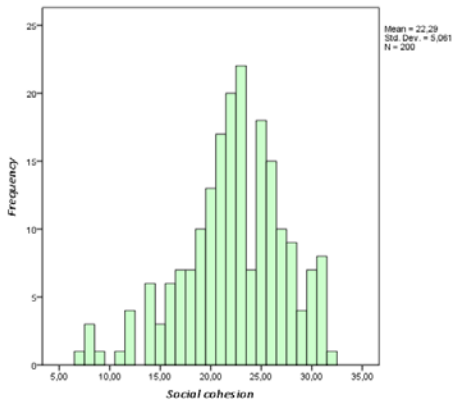

Figure 4.4: Histogram sum score social cohesion

Perception of walkability

Perception of walkability is measured by the Walkability Scale of Cerin et al. (2006). They composed a principal component analysis to find the items with the highest factor loadings. The current study uses these items to compose a walkability scale. Table 4.13 shows the frequencies of each of the selected items of the walkability scale. As can be observed from this table, most people are satisfied with the number of shops within walking or bicycling distance from their home, with the alternative routes in the neighbourhood and with the maintenance of footpaths.

Two items of the walkability scale are reverse-score items, namely 'road traffic' and 'night unsafety'. To compute the sum score of the walkability scale, these items are reversed. Four respondents did not answer all items of the walkability scale. These cases are replaced by the mean values.

Table 4.13: Walkability

	Completely disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Completely agree (%)	*Total (%)*
Walkability						
Shops within distance	5.5	2.0	4.5	30.5	57.5	100
Alternative routes	7.5	4.0	16.0	45.5	27.0	100
Maintenance footpaths	8.5	14.0	19.0	43.5	15.0	100
Places of interest	5.0	16.5	24.0	36.0	18.5	100
Road traffic (reversed)	4.0	9.5	23.5	50.0	13.0	100
Night unsafety (reversed)	2.0	8.0	25.5	45.5	19.0	100

After reversing two items and replacing missing values, Cronbach's Alpha is calculated to check the reliability of the walkability scale. When all six items are included, Alpha equals 0.640, which indicates that the scale is reliable. When the items 'road traffic' and 'night unsafety'' are deleted from the scale, Alpha increases to 0.687. The remaining four items of the walkability scale are a reliable representation of the perceived walkability in 's-Hertogenbosch, as is also shown in Table 4.14. The sum score is calculated, which ranges from 4 to 20. Here, 4 indicates neighbourhoods that are perceived to be inappropriate for walking, whereas 20 indicates neighbourhoods that are highly walkable. The mean of the sum score equals 15.04. Figure 4.5 shows the histogram of the distribution of walkability.

Table 4.14: Cronbach's Alpha Walkability

Walkability						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
4	20	15.037	10.149	3.187	4	0.687

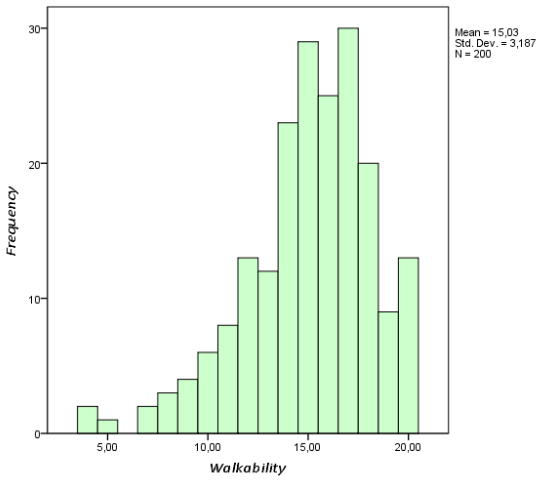

Figure 4.5: Histogram sum score walkability

4.5. Use of public space

Hadavi and Kaplan (2016) used three questions in their study to understand how respondents used the public space. These questions were also included in the questionnaire of the current study to receive data about the frequency of walking and cycling, the frequency of using specific public spaces and the frequency of doing specific activities. In line with the study of Hadavi and Kaplan (2016), a principal component analysis of all three variables is performed, to determine the components that can be used for further analysis. This section firstly describes the frequency distribution of the three original variables, after which the principal component analysis is explained.

4.5.1. Frequency of walking/ cycling

The first variable that was introduced by Hadavi and Kaplan (2016) and that was also used in the current study is the frequency of walking or cycling. The frequencies for each item are shown in Table 4.15. The table shows that people visit public space most frequently for pleasure or to make a purchase. Public space is least often used to walk the dog, to go to a bus stop, to go to a restaurant or to visit a specific place. Seven respondents did not fill in all items of the variable. Respondents who did not answer the frequency of walking the dog are assumed to not own a dog and therefore never walk the dog. The other missing values are replaced by the mean value.

Table 4.15: Frequency of walking/ cycling

	Never (%)	Less than once per month (%)	Once per month (%)	2 or 3 times per month (%)	Once per week (%)	2 to 5 times per week (%)	(Almost) daily (%)	*Total (%)*
Frequency of walking/ cycling								
For pleasure	14.5	12.5	4.5	12.5	15.0	13.0	28.0	100
To visit someone	15.0	12.0	12.0	17.5	17.0	15.5	11.0	100
To visit green space	19.5	16.0	9.5	16.5	13.0	10.0	15.5	100
To walk dog	75.0	0.5	1.0	0.5	0.5	2.5	20.0	100
To make purchase	6.0	5.5	4.5	8.0	20.0	31.5	24.5	100
To get to bus stop	55.0	19.5	5.5	10.0	3.5	4.5	2.0	100
To go to restaurant	36.0	32.0	8.0	7.5	10.5	5.0	1.0	100
To visit place	38.5	10.5	7.0	5.0	6.5	17.5	15.0	100

The Cronbach's Alpha is calculated for frequency of walking or cycling, as is shown in Table 4.16. Alpha equals 0.715 and increases to 0.721 when the item 'to get to bus stop' is deleted from analysis. Since the increase of alpha is minimal, it is decided to keep all items of the variable and use them for principal component analysis.

Table 4.16: Cronbach's Alpha Frequency of walking/ cycling

Frequency of walking/ cycling					
Minimum	Maximum	Mean	Variance	N of items	Cronbach's Alpha
8	56	27.898	84.067	8	0.715

4.5.2. Frequency of use of specific spaces

The next variable that was introduced by Hadavi and Kaplan (2016) is the frequency of use of specific spaces. Table 4.17 shows the frequencies of use in the current study. Here, it can be observed that people use parks quite frequently, while other public spaces, such as agricultural areas and day recreational areas are almost never visited. Seven respondents did not fill in all items of the variable. These missing cases are replaced by the mean value.

Table 4.17: Frequency of use of specific spaces

	Never (%)	Less than once per month (%)	Once per month (%)	2 or 3 times per month (%)	Once per week (%)	2 to 5 times per week (%)	(Almost) daily (%)	*Total (%)*
Frequency of use of specific spaces								
Park	23.0	15.5	12.0	13.0	10.0	10.0	16.5	100
Sport fields	69.5	12.5	1.5	4.0	5.5	7.0	0.0	100
Community garden	87.5	4.0	0.5	2.0	1.5	2.0	2.5	100
Day recreational area	83.5	7.0	4.0	1.0	2.5	0.5	1.5	100
Agricultural area	87.0	4.5	2.5	3.5	0.5	1.0	1.0	100
Forest	58.5	15.0	4.5	9.0	8.0	2.5	2.5	100
Other places	42.5	12.5	11.5	10.5	7.0	11.0	5.0	100

The Cronbach's Alpha is calculated to investigate the internal consistency of the variable. Table 4.18 indicates that alpha equals 0.650 for the frequency of use of specific spaces and does not increase when an item is deleted from the scale. This means that the variable is reliable and can be used in a principal component analysis.

Table 4.18: Cronbach's Alpha Frequency of use of specific spaces

Frequency of use of specific spaces					
Minimum	Maximum	Mean	Variance	N of items	Cronbach's Alpha
7	49	14.588	40.340	7	0.650

4.5.3. Frequency of specific activities

The third variable that was introduced by Hadavi and Kaplan (2016) is the frequency of specific activities, which exists of the items as shown in Table 4.19. This table shows that people cycle and walk in public space quite frequently, but do however not run, garden or picnic very often. Nine respondents did not fill in all items of this variable. These missing values are replaced by the mean value of the other responses.

Table 4.19: Frequency of specific activities

	Never (%)	Less than once per month (%)	Once per month (%)	2 or 3 times per month (%)	Once per week (%)	2 to 5 times per week (%)	(Almost) daily (%)	*Total (%)*
Frequency of specific activities								
Outdoor sitting and watching	38.0	17.0	4.5	5.5	10.5	8.5	16.0	100
Running	77.0	11.0	2.5	1.0	5.5	3.0	0.0	100
Biking	16.0	9.0	4.0	13.5	10.0	25.0	22.0	100
Outdoor gathering	19.0	12.0	12.0	22.5	12.5	20.0	2.0	100
Picnicking	76.5	18.0	3.5	1.0	1.0	0.0	0.0	100
Walking	13.0	8.0	6.0	16.0	12.5	17.5	26.0	100
Gardening	92.5	1.5	0.5	0.0	2.5	2.5	0.5	100
Other activities	52.5	16.0	8.5	5.0	8.5	6.0	3.5	100

Table 4.20 shows that the Cronbach's Alpha equals 0.506, which is rather low. Deleting the item 'running' increases alpha to 0.508. Since the increase of alpha is very minimal, it is decided to keep all items for the principal component analysis.

Table 4.20: Cronbach's Alpha Frequency of specific activities

Frequency of specific activities					
Minimum	Maximum	Mean	Variance	N of items	Cronbach's Alpha
8	56	22.645	43.559	8	0.506

4.5.4. Sum of public space use

Previously, the frequency distribution of the three variables of public space use were described, as introduced by Hadavi and Kaplan (2016) and adapted to the current study. A principal component analysis with orthogonal rotation (varimax) is conducted to reduce the number of items of three variables of use of public space. The Cronbach's Alpha for each variable has been determined and showed that all items of the three variables can be included in the principal component analysis. With an eigenvalue of one, six components arise. Together, these components account for 58% of the variance. Table 4.21 shows the results of the principal component analysis with varimax rotation.

Component 1 'Recreational use': The first component loads on parks, walking, visiting green spaces, visiting them for pleasure and walking with the dog. The items of the component are all based on visiting a park or another public space for recreational purposes and to relax.

Component 2 'Purposeful use and cycling': The second component loads on biking, visiting someone or a specific place and making purchases. The items of the second component provide opportunities to visit green space and to meet people while visiting.

Component 3 'Gardening': The third component loads on community garden and gardening in a community garden, but also on day recreational area and agricultural area. These items have in common that they identify specific types of public spaces which can be used for purposes such as gardening.

Component 4 'Active use': The fourth component loads on picnicking, running, visiting a restaurant and other places. This component exists of items that are active of nature.

Component 5 'Passive use': The fifth component loads on outdoor sitting and watching, other activities, getting to a bus stop, and gathering outdoors.

Component 6 'Visit green space': The sixth component loads on sport fields and forests. These two items are other green spaces that can be visited.

Table 4.21: Principal Component Analysis Public space use

Public space use						
	Rotated Factor Loadings					
	Recreational use	Purposeful use & cycling	Gardening	Active use	Passive use	Visit green space
Park	**0.809**	0.066	-0.022	0.207	0.182	0.136
Walking	**0.743**	0.203	0.093	-0.031	-0.054	0.038
To visit green space	**0.732**	0.114	0.152	0.249	0.082	0.001
For pleasure	**0.690**	0.201	0.140	-0.001	0.124	0.069
To walk dog	**0.608**	0.017	0.151	-0.215	-0.287	0.041
Biking	0.074	**0.745**	0.123	0.064	-0.075	0.279
To visit someone	0.237	**0.734**	-0.046	0.007	0.109	0.160
To visit place	0.037	**0.658**	-0.001	0.291	0.190	-0.041
To make purchase	0.380	**0.576**	0.002	0.074	0.098	-0.056
Community garden	0.222	0.079	**0.860**	-0.023	0.111	0.054
Gardening	0.047	0.025	**0.851**	-0.123	-0.026	-0.094
Agricultural area	0.198	-0.117	**0.537**	0.304	-0.065	0.361
Day recreational area	0.108	0.113	**0.393**	0.361	0.162	0.386
Picnicking	0.033	0.100	0.073	**0.768**	0.091	0.011
Running	-0.024	0.051	-0.157	**0.680**	-0.170	0.204
To go to restaurant	0.183	0.306	-0.012	**0.519**	0.427	-0.042
Other places	0.311	0.242	0.110	**0.341**	0.130	0.115
Outdoor sitting and watching	0.395	0.021	0.030	0.143	**0.598**	-0.168
Other activities	-0.188	0.277	0.202	-0.041	**0.582**	0.236
To get to bus stop	0.126	0.372	0.199	0.324	**-0.488**	-0.298
Outdoor gathering	0.125	0.399	0.023	0.085	**0.481**	0.261
Sport fields	-0.007	0.254	-0.128	0.035	0.067	**0.683**
Forest	0.219	0.027	0.301	0.160	0.083	**0.564**
Eigenvalues	5.315	2.302	1.855	1.489	1.332	1.087
% of variance	23.110	10.007	8.066	6.473	5.790	4.726

4.6. Loneliness

The three-item loneliness scale, as introduced by Hughes et al. (2004), is used to understand the extent to which participants feel lonely. Table 4.22 shows that respondents hardly ever feel lonely. Only some respondents feel that they miss companionship some of the time. Seven respondents did not fill in all items of the loneliness scale. These missing values are replaced by the mean value.

The Cronbach's Alpha is calculated, to verify whether the three-item loneliness scale is consistent and reliable and whether a sum score can be calculated. Table 4.23 shows that the Cronbach's Alpha equals 0.843, which is high. Deleting an item from the scale would increase alpha to 0.854. However, since 0.843 is an acceptable value of alpha and because the scale was proved to be consistent in previous studies, no items are deleted from the scale.

After the replacement of the missing values by the mean value and calculating the Cronbach's Alpha, a sum score is calculated, which equals 3.82. The sum score ranges from 3 (people who seldom feel lonely) to 9 (people who feel lonely most of the time) and is also shown in the histogram of Figure 4.6.

Table 4.22: Loneliness

	Miss companionship (%)	Feel left out (%)	Feel isolated (%)
Loneliness			
Hardly ever	67.0	82.0	82.5
Some of the time	27.5	15.0	14.5
Often	5.5	3.0	3.0
Total (%)	100	100	100

Table 4.23: Cronbach's Alpha Loneliness

Loneliness						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
3	9	3.818	1.842	1.357	3	0.843

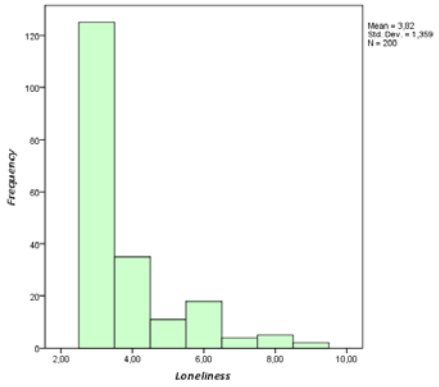

Figure 4.6: Histogram Sum score Loneliness

4.7. Life satisfaction

Finally, life satisfaction is measured by the Satisfaction With Life Scale of Diener et al. (1985), who used five statements to understand people's satisfaction with their life. Table 4.24 shows that most respondents are satisfied with their life. Some respondents indicated to do things differently if they could live their life over. Six respondents did not fill in all items of the life satisfaction scale. These missing values are replaced by the mean value of the other responses for these items.

Cronbach's Alpha is calculated to verify whether the Satisfaction with Life Scale is consistent and reliable. Table 4.25 shows that Cronbach's Alpha equals 0.864, which is high. Deleting an item from the scale does not increase alpha, meaning that the scale is reliable and consistent. A sum score is calculated, which ranges from 5 to 25, where 5 indicates people who are dissatisfied with their life and 25 people who are very satisfied with their life. The mean of the sum score equals 18.29. The histogram of Figure 4.7 shows the distribution of life satisfaction, which indicates that most respondents are quite satisfied with their life.

Table 4.24: Life satisfaction

	Completely disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Completely agree (%)	*Total (%)*
Life satisfaction						
In most ways my life is close to ideal.	4.5	11.5	20.0	43.0	21.0	100
The conditions of my life are excellent.	3.5	9.5	22.5	44.5	20.0	100
I am satisfied with my life.	1.0	5.5	19.0	49.5	25.0	100
So far, I have gotten the important things I want in life.	1.5	11.5	22.0	47.0	18.0	100
If I could live my life over, I would change almost nothing.	5.0	18.5	25.5	36.0	15.0	100

Table 4.25: Cronbach's Alpha life satisfaction

Life satisfaction						
Minimum	Maximum	Mean	Variance	Std. dev.	N of items	Cronbach's Alpha
5	25	18.292	16.279	4.035	5	0.864

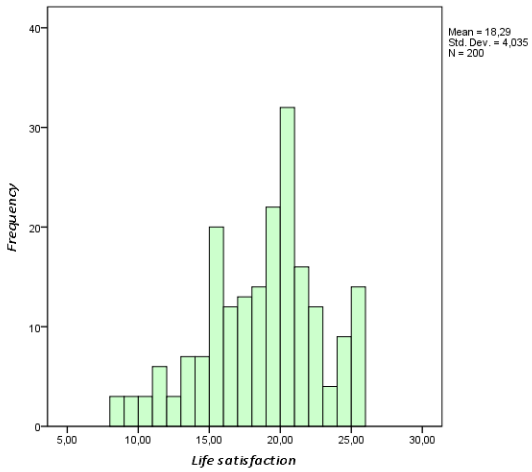

Figure 4.7: Histogram Sum Life satisfaction

4.8. Sample distribution per neighbourhood

In previous sections the distribution of the variables is described for the entire sample. To determine whether differences in the distribution of the sample between the three neighbourhoods exist, Pearson Chi-Square tests and ANOVA tests are performed. Table 4.26 shows the results of the Chi-Square tests and ANOVA tests. The three most right columns of the table indicate the distribution per variable for the three neighbourhoods. For the Chi-Square tests percentages per category of each variable are shown and for the ANOVA tests the mean values are shown.

The tests show that age, education, household composition, activities of daily living, car use as a driver, bus use, train use, Euclidean distance, neighbourhood attachment, perception of walkability, recreational use, purposeful use and cycling, active use and passive use differ significantly between the three neighbourhoods. For each of the variables, the differences between the three neighbourhoods will now be discussed.

Table 4.26: Demographics of sample per neighbourhood

Neighbourhood demographics					
Pearson Chi-Square test	χ^2	*Sig.*	*Maaspoort (%) N=107*	*Binnenstad (%) N=42*	*Rosmalen Zuid (%) N=51*
Gender	1.444	0.486			
Male			24.3	28.6	33.3
Female			75.7	71.4	66.7
Total			100	100	100
Age	**27.360****	**0.000**			
18-35 years			22.4	45.2	15.7
36-55 years			39.3	11.9	15.7
56 years or older			38.3	42.9	68.6
Total			100	100	100
Education	**16.458****	**0.002**			
Low			15.0	14.3	37.3
Moderate			29.9	14.3	21.6
High			55.1	71.4	41.2
Total			100	100	100
Income	9.256	0.160			
Low			16.8	23.8	33.3
Moderate			47.7	40.5	29.4
High			29.0	33.3	27.5
Unknown			6.5	2.4	9.8
Total			100	100	100
Household composition	**33.498****	**0.000**			
One-person household			17.8	35.7	43.1
Household without children			30.8	57.1	29.4
Household with children			51.4	7.1	27.5
Total			100	100	100
ANOVA test	*F*	*Sig.*	*Maaspoort (Mean)*	*Binnenstad (Mean)*	*Rosmalen Zuid (Mean)*
Activities of daily living (18-72)	**14.414****	**0.000**	19.84	20.52	27.29
Car use (as a passenger) (1-7)	2.438	0.090	4.35	3.81	4.67
Car use (as a driver) (1-7)	**3.728***	**0.026**	5.59	4.58	5.23
Bus use (1-7)	**4.704****	**0.010**	2.37	2.28	1.60
Train use (1-7)	**5.551****	**0.005**	2.23	3.13	2.18
Social cohesion (7-35)	2.622	0.075	22.13	21.19	23.53
Neighbourhood attachment (6-30)	**5.617****	**0.004**	17.83	20.06	20.09
Perception of walkability (4-20)	**4.851****	**0.009**	14.71	16.36	14.59
Recreational use (5-35)	**9.069****	**0.000**	20.42	20.96	15.06
Purposeful use and cycling (4-28)	**12.074****	**0.000**	16.69	21.03	15.33
Gardening (4-28)	1.617	0.201	5.09	5.77	6.02
Active use (4-28)	**30.460****	**0.000**	7.68	12.68	7.79
Passive use (4-28)	**9.287****	**0.000**	10.39	13.64	11.46
Visit green space (2-14)	1.768	0.173	3.64	4.21	4.37
Loneliness (3-9)	0.963	0.384	3.71	4.05	3.86
Life satisfaction (5-25)	0.351	0.704	18.51	18.15	17.96
Euclidean distance (1-5)	**4.114***	**0.019**	2.60	3.32	3.39

* Significant at the 0.05 level (2-tailed).

** Significant at the 0.01 level (2-tailed).

Gender

Table 4.26 shows that in all three neighbourhoods more female than male respondents answered the questionnaire, with the highest percentage of females in Maaspoort (75.7%). The p-value equals 0.486, which indicates that the difference in gender distribution between the three neighbourhoods is not significant.

In the questionnaire, respondents were also asked to indicate their residential location. Figure 4.8 shows the spatial distribution of males and females over the three neighbourhoods of 's-Hertogenbosch. The lightest colour indicates male respondents, whereas the darker colour indicates female respondents. In Rosmalen Zuid a cluster of males seems to exist, whereas in the inner city and in Maaspoort a random distribution of males and females can be observed.

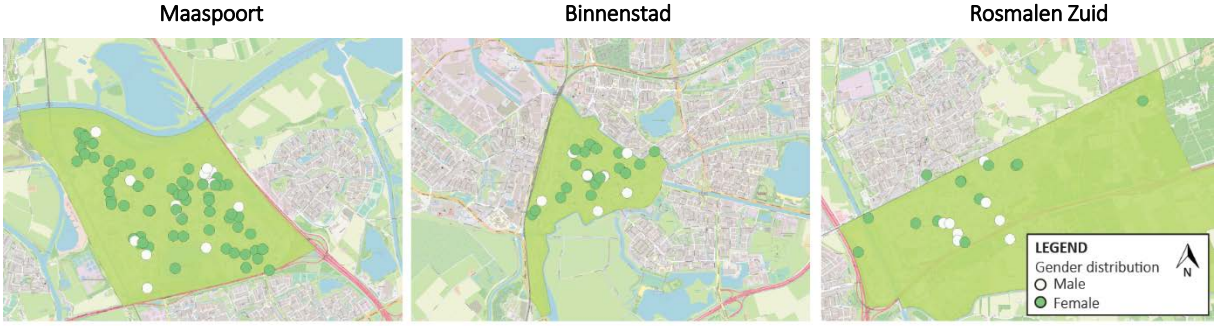

Figure 4.8: Spatial distribution gender

Age

Table 4.26 shows the age distribution of participants over the three neighbourhoods. The table shows that especially in Rosmalen Zuid a high percentage of people aged above 56 responded to the questionnaire (68.6%), whereas in Maaspoort a more equal age distribution is found. The p-value equals 0.000, indicating that significant differences between the three neighbourhoods exist. Figure 4.9 shows the spatial distribution of people of different age groups over the three neighbourhoods of 's-Hertogenbosch. The lightest colour indicates respondents who are aged between 18 and 35, whereas the darkest colour indicates the oldest respondent group. People of different ages are randomly distributed over the three neighbourhoods, although a somewhat more clustered distribution of the highest aged respondents can be observed in Rosmalen Zuid. The observed cluster occurs because of the elderly care centre that was visited in Rosmalen Zuid.

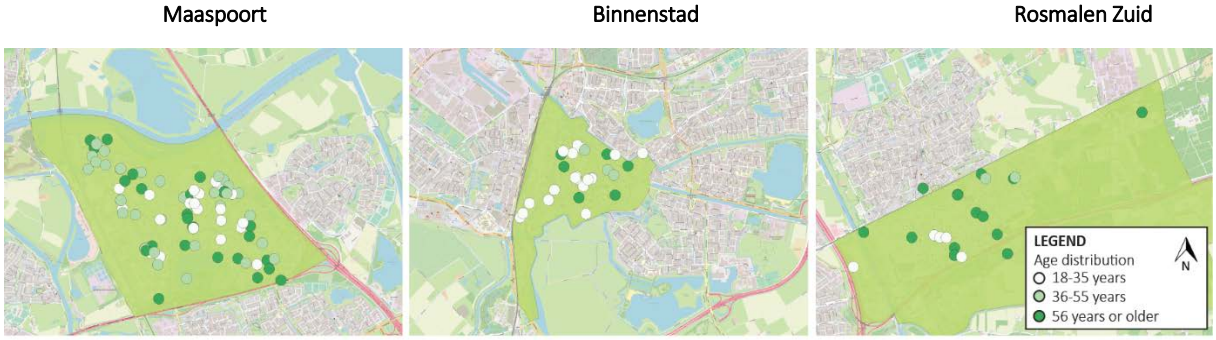

Figure 4.9: Spatial distribution age

Education

For the three neighbourhoods, the highest percentage of respondents with a high education is observed in the inner city (71.4%). The differences in respondents' educational background in the neighbourhoods are tested by a Pearson Chi-Square test. The p-value of the test equals 0.002, indicating that significant differences in educational background exist between the residents of the three neighbourhoods. These differences can also be observed in the spatial distribution of Figure 4.10. In Binnenstad, highly educated respondents are clustered around the main square of the city. In Maaspoort, it seems that respondents with a high education also live somewhat clustered. The clustered distribution of people with different education backgrounds may be related to job opportunities or with the economic value of residences.

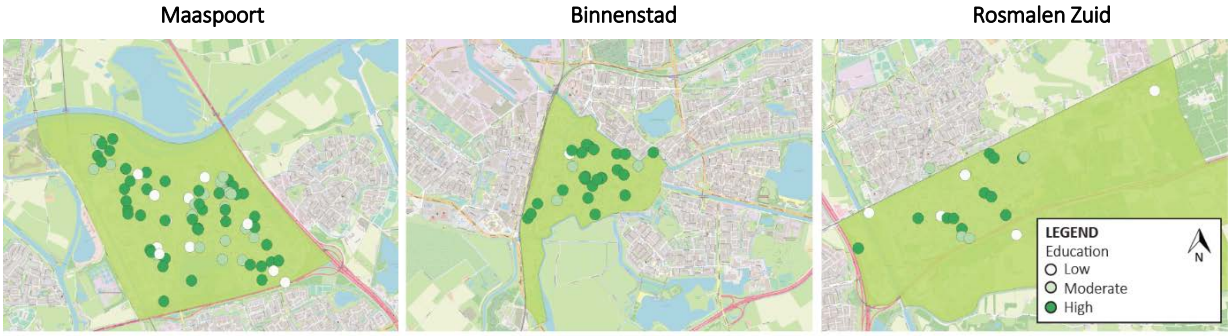

Figure 4.10: Spatial distribution education

Income

Most respondents with a low income live in Rosmalen Zuid (33.3%). In Binnenstad, most respondents with a high income reside (33.3%). The p-value indicates that there are no significant differences in income between the neighbourhoods. Figure 4.11 shows the spatial distribution of the income of residents over the neighbourhoods. It can be observed that there are some small clusters in the northern part of Maaspoort with high-income residents. In the inner city a cluster also seems to exist in the northern area of the neighbourhood.

Figure 4.11: Spatial distribution income

Household composition

Each neighbourhood is characterized by a high percentage of one of the three household compositions. In Maaspoort, 51.4% of the respondents live with children, in Binnenstad 57.1% live without children and in Rosmalen Zuid 43.1% live alone. Differences in household composition are significant. Figure 4.12 shows these differences. In Maaspoort, households with children mostly indicated to live at the outskirts of the neighbourhood. In Binnenstad, singles mainly live in the northern areas of the neighbourhood, whereas in Rosmalen Zuid the distribution seems to be more random.

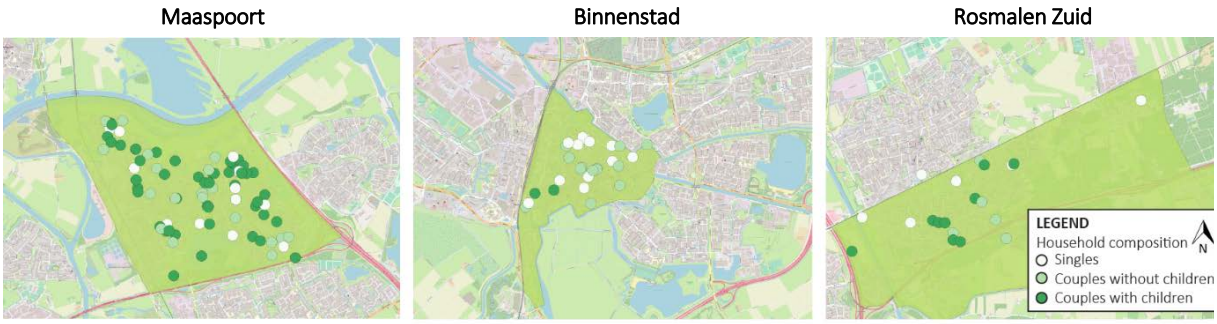

Figure 4.12: Spatial distribution household composition

ANOVA tests

For the ordinal and ratio variables ANOVA tests are performed to observe the significant differences between the three neighbourhoods. As is shown in Table 4.26, activities of daily living (ADL) differ significantly between the neighbourhoods. Especially in Maaspoort, people have a lower ADL and are more restricted in the performance of daily activities. For car use as a driver significant differences are also found, with the highest mean value in Maaspoort (M=5.59, SD=1.85). The highest mean value of bus use is found in Maaspoort (M=2.37, SD=1.69) and the highest value of train use in Binnenstad (M=3.13, SD=1.84).

Subjective neighbourhood characteristics that differ significantly between the three neighbourhoods are neighbourhood attachment and perception of walkability. In Rosmalen Zuid, people are most attached to their neighbourhood (M=20.09, SD=4.75). The perception of walkability has the highest mean value in Binnenstad (M=16.39, SD=3.02).

Significant differences between the three neighbourhoods for the use of public space are found for recreational use, purposeful use and cycling, active use and passive use. As is shown in table 4.26, recreational space use is the highest in Binnenstad (M=20.96, SD=6.55). People in Binnenstad also most frequently purposefully use public space and cycle (M=21.03, SD=4.91) and most often actively (M=12.68, SD=4.65) or passively (M=13.64, SD=4.89) use public space.

No significant differences are found for the variables car use as a passenger, social cohesion, gardening, visit green space, loneliness and life satisfaction. Since the distributions of these variables do not differ and because of the small sample in Binnenstad and Rosmalen Zuid, it is decided to use one sample of residents of ‘s-Hertogenbosch instead of three samples of residents for each neighbourhood.

Euclidean distance to public space

For Figures 4.8 to 4.12, the residential locations that respondents drew on a map were used. In the questionnaire, respondents were also asked to indicate the public spaces that they visited more than once per week. The indicated public spaces are shown in Figures 4.13 to 4.15. Each of these figures shows a neighbourhood with all the public spaces that were indicated to be used frequently by the residents of one of these neighbourhoods.

Distances between the residential location and public spaces can be calculated, using the Euclidean distance formula, in which the x and y coordinate of the drawn public space are subtracted from the a and b coordinate of the residential location. For each respondent, the distance between the residential location and the drawn public spaces is calculated, using the following formula:

$$distance\big((x,y),(a,b)\big) = \sqrt{(x-a)^2 + (y-b)^2}$$

105 of the 200 participants of the survey drew public spaces on the map. On average, 4.36 spaces were indicated by the participants, with a range from 1 to 12 places. Table 4.27 shows the results of the frequency distribution of the average distances between the residence and the public space on the respondent level. This table shows that most respondents use public spaces that are within 301 to 600 meters more than once per week. Table 4.26 shows, in addition, that in Rosmalen Zuid the mean distance between public spaces and respondents' residences is the largest (M=3.39, SD=1.54). Table 4.27 also shows that the frequency of use is higher for spaces that are 1201 meters or further away than for spaces between 901 and 1200 meters. The spaces at further distances may have other characteristics, such as a higher quality or more facilities, which makes walking or cycling to these places more valuable. Since only 105 out of 200 participants drew public spaces on a map, the Euclidean distance will not be used in further analyses.

Table 4.27: Euclidean distance

	Frequency (N)	Percent (%)
Euclidean distance		
0-300m	19	18.1
301-600m	26	24.8
601-900m	25	23.8
901-1200m	16	15.2
1201m or further	19	18.1
Total	105	100

4.9. Conclusion

This chapter showed the sample distribution of the variables that will be used in bivariate analyses and path analysis in concurring chapters. Somewhat more elder people responded to the questionnaire, who are quite independent in performing activities of daily living. More women than men responded. Most people indicated to live in Maaspoort and to be born in the Netherlands. For the three variables of public space use a principal component analysis was performed, to reduce the number of items for these variables to six components. These components all indicate a different use of public space and will be used in next chapters to gain knowledge about the frequency of use of different public spaces.

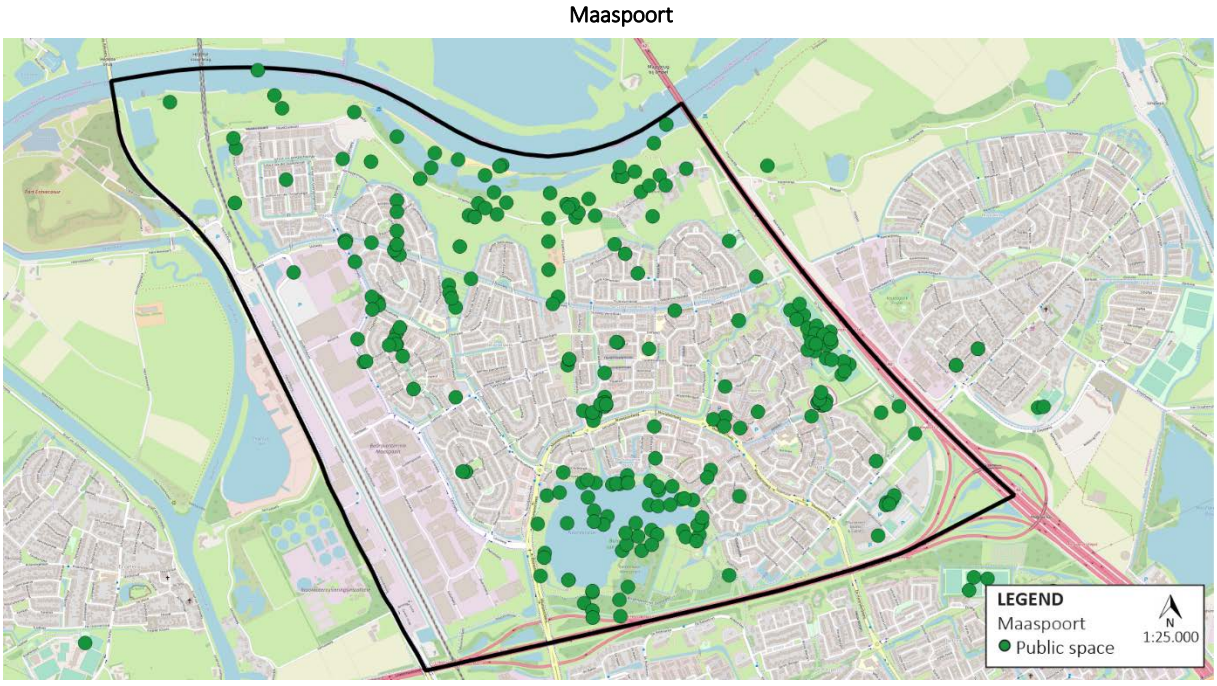

Figure 4.13: Public spaces in Maaspoort

Binnenstad

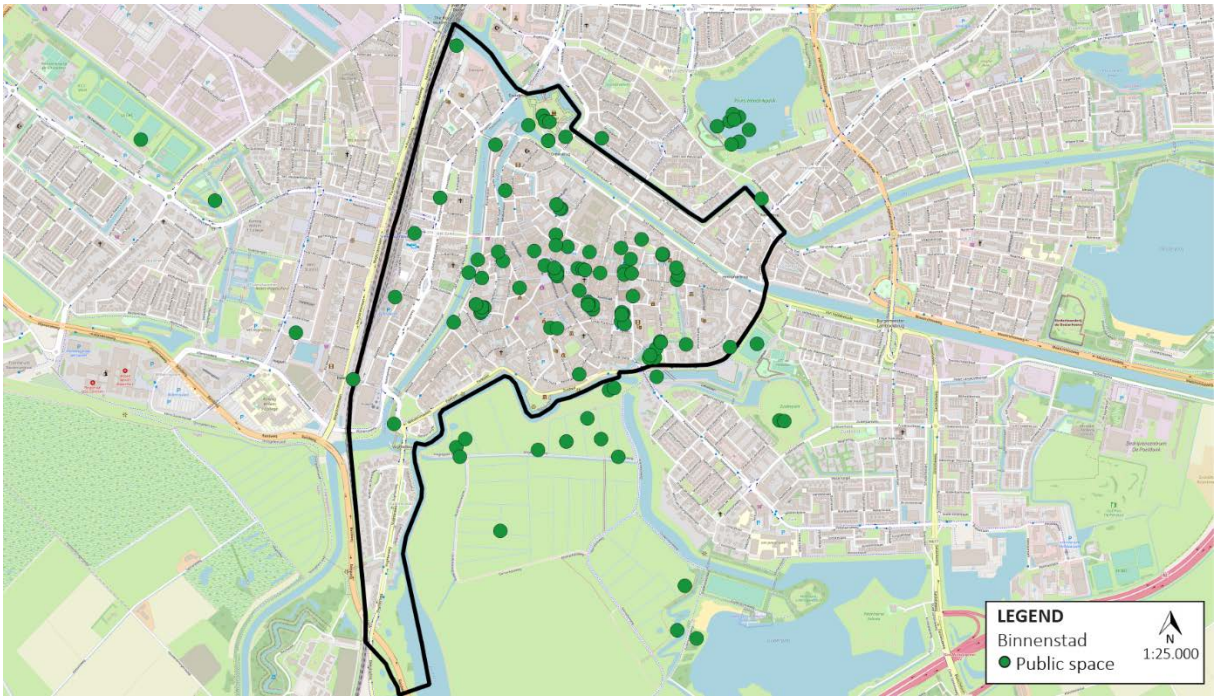

Figure 4.14: Public spaces in Binnenstad

Rosmalen Zuid

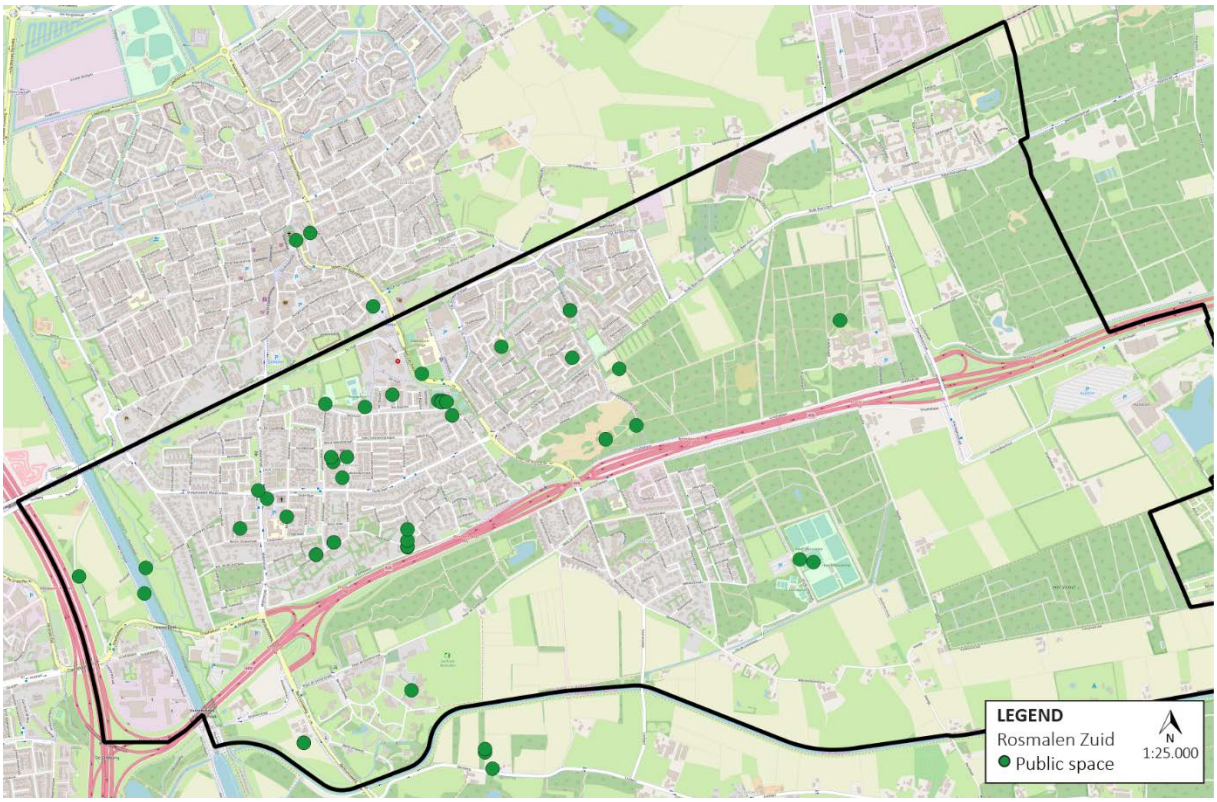

Figure 4.15: Public spaces in Rosmalen Zuid

5. Bivariate analysis

In previous chapters the variables that were introduced in the questionnaire have been discussed, after which the distribution of these variables were described. In the current chapter the bivariate analyses between the independent and dependent variables, as indicated in the conceptual model, will be performed, to discover significant relationships. The relationships between personal characteristics and characteristics of a neighbourhood and public space use, loneliness and life satisfaction will be obtained. Moreover, the relationships between use of public space, loneliness and life satisfaction will be determined.

5.1. Bivariate analysis

Bivariate analyses are carried out to find significant relationships between two variables. Three different tests are used, depending on the measurement scale of the variables. This section introduces the tests that can be run to find the significant relationships.

Independent t-test

The independent t-test is used to compare two means in different, independent groups of the sample. Firstly, it should be tested whether the significance value of the Levene's test is smaller than 0.05 or 0.01. If this is the case, the null hypothesis that variances are equal should be rejected, meaning that there is a significant difference in variance (Field, 2009). Equal variances are then not assumed. The second step is to check whether the difference between the means of the two groups is significant. If the significance value is smaller than 0.05, the difference in means is significant. The null hypothesis that the means of the two independent groups are equal should be rejected and the alternative hypothesis should be accepted.

One-way ANOVA

The analysis of variance (ANOVA) is used when more than two conditions are compared. The null hypothesis states that all group means are equal and should be rejected when the significance value is smaller than 0.05 or 0.01. A F-ratio is calculated, which compares the amount of systematic variance in the data to the amount of unsystematic variance. If the F-ratio is smaller than 1, the effect will always be non-significant. When the F-ratio is bigger than 1, there will be a significant difference between the tested group means. A post hoc test should be performed to find the differences between the tested groups. Post hoc tests are carried out to observe different combinations of groups (pairwise comparisons) (Field, 2009).

Pearson's correlation

The standardization of the covariance results in values between -1 and +1, where -1 indicates a perfect negative relationship between two variables and +1 indicates a perfect positive relationship between two variables. A positive relationship means that the increase of one variable causes the other variable to increase as well. When one variable increases and the other variable decreases, a negative relationship exists between the two variables. When a relationship is 0, it means that there is no linear relationship between two variables.

Pearson's correlation tests are performed when both variables are measured on an interval level and when the distribution of the sample is normal. The null hypothesis that two variables are not related can be tested by the Pearson's test. If the significance value is smaller than 0.01 or 0.05, the null hypothesis that there is no relationship should be rejected. The alternative hypothesis that there is a relationship should thus be accepted (Field, 2009).

5.2. Recreational use

This section describes the bivariate analyses that are carried out to find whether a significant relationship exists between personal characteristics, objective and subjective neighbourhood characteristics and recreational use. Recreational use is one of the components of public space use, which were found after principal component analysis in section 4.5.4. Recreational space use exists of activities that are done and places that are visited to relax and to recreate. Figure 5.1 shows the potential relationships.

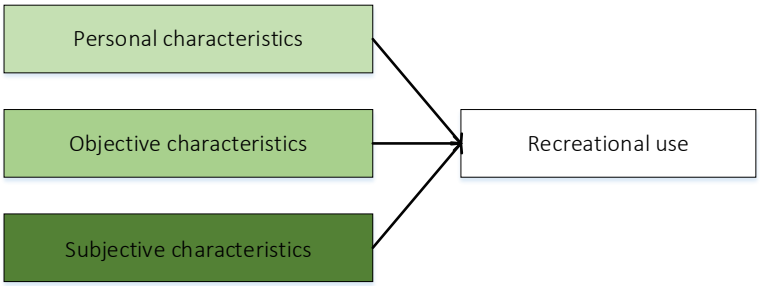

Figure 5.1: Recreational use

5.2.1. Personal characteristics

To test whether significant relationships exist, t-tests, ANOVA and Pearson's correlations are performed. The t-test is used to analyse the relationship between the nominal variable gender and the dependent variable of interval scale. ANOVA is used to test relationships between variables with more than two categories and the dependent variable. The Pearson's correlation test is used to test the relationship between two interval variables. The results of the tests are shown in Table 5.1.

Table 5.1 shows that there are two statistically significant relationships. Firstly, a significant difference between income levels can be observed. The Bonferroni post hoc test is used to observe how recreational space use differs between people with different income levels. The test indicates that at the 0.05 significance level no significant differences occur. Between the lowest income group and people who do not know their income, a p-value of 0.105 is found. Other values of the multiple comparisons are higher than 0.105. The insignificance may be caused by the difference in mean value between the different income groups. In general, people with different monthly incomes differ in their recreational use of public space.

Another significant relationship can be observed between activities of daily living and recreational use. Table 5.1 shows that the Pearson's correlation is negative, which indicates that people who are more dependent on others in performing daily activities score lower on recreational use than people who are not dependent on others.

No significant differences in recreational use are found between gender, age, education and household composition. In addition, no significant relationships are found between car use (as a passenger and as a driver), bus use and train use and recreational use. There seems to be no significant relationship between different transport modes and recreational space use.

Table 5.1: Bivariate analysis Personal characteristics – Recreational use

Recreational use				
t-test	*Mean*	*St. Dev.*	*t.*	*Sig.*
Gender			1.235	0.218
Male	20.226	7.792		
Female	18.634	8.262		
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Age			2.063	0.130
18-35 years	17.283	7.519		
36-55 years	20.456	8.744		
56 years or older	19.233	8.021		
Education			2.321	0.101
Low	16.673	8.728		
Moderate	19.368	8.050		
High	19.834	7.868		
Income			**2.923***	**0.035**
Low	16.174	8.412		
Moderate	19.339	8.149		
High	19.832	6.846		
Unknown	22.231	10.068		
Household composition			2.699	0.070
One-person household	17.635	8.504		
Household without children	20.784	7.969		
Household with children	18.477	7.846		
Pearson's correlation			*r.*	*Sig.*
Activities of daily living			**-0.262****	**0.000**
Car use as a passenger			-0.089	0.208
Car use as a driver			0.000	0.996
Bus use			0.028	0.698
Train use			0.002	0.982

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.2.2. Objective characteristics

An ANOVA test is conducted to find significant differences between the neighbourhoods of 's-Hertogenbosch. As is shown in Table 5.2, there is a significant difference in recreational space use between the three neighbourhoods. A post hoc Bonferroni test shows that there is a significant difference in recreational use between residents of Maaspoort (M=20.242, SD=7.934) and Rosmalen Zuid (M=15.066, SD=8.560) and between residents of Binnenstad (M=20.956, SD=6.552) and Rosmalen Zuid. Residents of Maaspoort and Binnenstad score higher on recreational space use than residents of Rosmalen Zuid. This may be caused by the difference in availability of green spaces and parks between the three neighbourhoods or by differences in the sample.

Table 5.2: Bivariate analysis Objective characteristics – Recreational use

Recreational use				
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Neighbourhood			**9.069****	**0.000**
Maaspoort	20.242	7.934		
Binnenstad	20.956	6.552		
Rosmalen Zuid	15.066	8.560		

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.2.3. Subjective characteristics

Table 5.3 shows that significant relationships between neighbourhood attachment and social cohesion and recreational use can be observed. Pearson's correlation tests are performed to test which relationships are statistically significant at the 0.05 or 0.01 level. The positive correlations indicate that residents who are attached to their neighbourhood and who report to live in neighbourhoods with high social cohesion, score higher on recreational use than residents who are not attached to their neighbourhood or who do not indicate to live in neighbourhoods with high social cohesion.

Table 5.3: Bivariate analysis Subjective characteristics - Recreational use

Recreational use		
Pearson's Correlation	*r.*	*Sig.*
Neighbourhood attachment	**0.189****	**0.007**
Social cohesion	**0.159***	**0.025**
Perception of walkability	0.091	0.201

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.3. Purposeful use and cycling

After the description of the bivariate analyses with recreational use, this section describes the bivariate analyses that are performed to find significant relationships between personal characteristics, objective and subjective neighbourhood characteristics and purposeful space use and cycling. Purposeful use and cycling exists of opportunities to visit specific places or to meet people in public space. Figure 5.2 shows the relationships that will be tested.

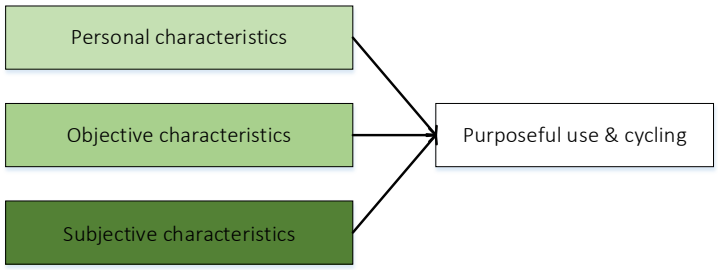

Figure 5.2: Purposeful use and cycling

5.3.1. Personal characteristics

Table 5.4 shows the personal characteristics that have been tested on their relationship with purposeful use and cycling. The table shows that there is a significant difference between males and females in their frequency of cycling and their purposeful visits. Males score higher on purposeful use and cycling than females.

Other significant relationships are found between activities of daily living, car use as a driver, bus use and train use and purposeful use and cycling. The negative relationship with activities of daily living indicates that people who are more dependent on others in their performance of daily activities, cycle less often and less frequently use public space for specific purposes. The positive relationship between train use, bus use and car use as a driver indicates that people who use the bus, train or car more frequently, also score higher on purposeful use and cycling.

No significant differences are found between age, education, income, household composition and car use as a passenger. Purposeful use and cycling thus does not differ between people of different ages, educational backgrounds, income levels, household compositions or frequency of car use as a passenger.

Table 5.4: Bivariate analysis Personal characteristics – Purposeful use and cycling

Purposeful use and cycling				
t-test	*Mean*	*St. Dev.*	*t.*	*Sig.*
Gender			**2.112***	**0.036**
Male	18.730	5.384		
Female	16.690	6.347		
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Age			0.856	0.426
18-35 years	18.207	6.462		
36-55 years	16.762	6.107		
56 years or older	17.019	6.016		
Education			2.836	0.061
Low	15.366	6.355		
Moderate	17.114	5.881		
High	18.015	6.093		
Income			1.521	0.210
Low	16.940	6.162		
Middle	17.031	6.260		
High	18.374	5.721		
Unknown	14.639	6.944		
Household composition			0.751	0.473
One-person household	16.743	7.126		
Household without children	17.955	5.685		
Household with children	16.943	5.799		
Pearson's Correlation			*r.*	*Sig.*
Activities of daily living			**-0.260****	**0.000**
Car use as a passenger			0.028	0.691
Car use as a driver			**-0.231****	**0.001**
Bus use			**0.221****	**0.002**
Train use			**0.325****	**0.000**

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.3.2. Objective characteristics

The three selected neighbourhoods of 's-Hertogenbosch are used to test differences in purposeful use and cycling of residents. Table 5.5 shows that a significant difference exists in purposeful use and cycling. A Bonferroni post hoc test is performed to test which neighbourhoods differ. The results of the test indicate that significant differences exist between Maaspoort (M=16.687, SD=6.007) and Binnenstad (M=21.028, SD=4.908) and between Binnenstad and Rosmalen Zuid (M=15.325, SD=6.160).

Table 5.5: Bivariate analysis Objective characteristics – Purposeful use and cycling

Purposeful use and cycling				
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Neighbourhood			**12.074****	**0.000**
Maaspoort	16.687	6.007		
Binnenstad	21.028	4.908		
Rosmalen Zuid	15.325	6.160		

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.3.3. Subjective characteristics

Bivariate analyses are carried out between the subjective characteristics neighbourhood attachment, social cohesion and the perception of walkability and purposeful use and cycling. Table 5.6 shows that significant relationships exist between social cohesion and the perception of walkability. People who live in neighbourhoods with high social cohesion and walkability scores, more frequently cycle and use public space with a specific purpose.

Table 5.6: Bivariate analysis Subjective characteristics – Purposeful use and cycling

Purposeful use and cycling		
Pearson's Correlation	*r.*	*Sig.*
Neighbourhood attachment	0.130	0.066
Social cohesion	**0.188****	**0.008**
Perception of walkability	**0.360****	**0.000**

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.4. Gardening

The third component that arose after the principal component analyses on the three variables of use of public space, is gardening. Figure 5.3 shows the relationships that are expected to exist between personal characteristics, objective and subjective neighbourhood characteristics and gardening.

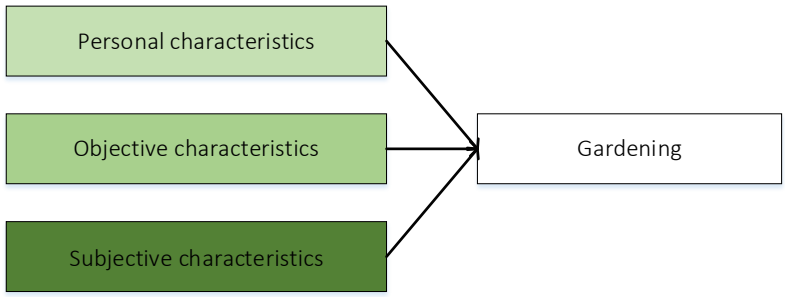

Figure 5.3: Gardening

5.4.1. Personal characteristics

The first relationships that are tested, are the relationships between personal characteristics and gardening. As is shown in Table 5.7, no significant relationships exist between personal characteristics and gardening. This shows that there is no significant difference in the frequency of gardening between males and females, between people of different age groups, educational backgrounds, income levels and household compositions. Moreover, no significant relationships are found between the activities of daily living, different transport modes and gardening. The insignificant relationships may be caused by the limited number of people who indicated to visit community gardens, day recreational areas or agricultural areas frequently.

Table 5.7: Bivariate analysis Personal characteristics – Gardening

Gardening				
t-test	*Mean*	*St. Dev.*	*t.*	*Sig.*
Gender			1.931	0.057
Male	6.280	3.890		
Female	5.159	2.995		
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Age			0.058	0.944
18-35 years	5.333	3.485		
36-55 years	5.535	3.420		
56 years or older	5.500	3.144		
Education			1.609	0.203
Low	4.665	1.739		
Moderate	5.526	3.327		
High	5.740	3.675		
Income			0.812	0.488
Low	5.174	3.024		
Moderate	5.275	3.085		
High	5.719	3.581		
Unknown	6.571	4.144		

Gardening				
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Household composition			1.035	0.357
One-person household	5.298	3.341		
Household without children	5.908	3.544		
Household with children	5.159	2.982		
Pearson's Correlation			*r.*	*Sig.*
Activities of daily living			0.003	0.965
Car use as a passenger			-0.078	0.496
Car use as a driver			0.004	0.958
Bus use			-0.037	0.607
Train use			0.046	0.522

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.4.2. Objective characteristics

Table 5.8 shows that no significant differences are found between people of different neighbourhoods and the frequency of gardening. This indicates that the frequency of gardening does not depend on the neighbourhood in which a respondent lives.

Table 5.8: Bivariate analysis Objective characteristics – Gardening

Gardening				
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Neighbourhood			1.617	0.201
Maaspoort	5.086	2.898		
Binnenstad	5.767	3.383		
Rosmalen Zuid	6.020	3.911		

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.4.3. Subjective characteristics

No significant relationships can be observed between the subjective neighbourhood characteristics neighbourhood attachment, social cohesion, perception of walkability and the frequency of gardening. Table 5.9 shows the results of the bivariate analyses that are carried out between the subjective characteristics and gardening. Both personal characteristics and subjective and objective neighbourhood characteristics do not significantly affect the frequency of gardening. Therefore, this component can be deleted from further analyses.

Table 5.9: Bivariate analysis Subjective characteristics – Gardening

Gardening		
Pearson's Correlation	*r.*	*Sig.*
Neighbourhood attachment	0.132	0.062
Social cohesion	0.113	0.110
Perception of walkability	0.109	0.124

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.5. Active use

The fourth component of the principal component analysis is active use, which exists of activities such as running and visiting a restaurant. Figure 5.4 shows the possible relationships between the personal characteristics, objective and subjective neighbourhood characteristics and active use. This section presents the results of the bivariate analyses that have been performed to find significant relationships between the independent variables and active use.

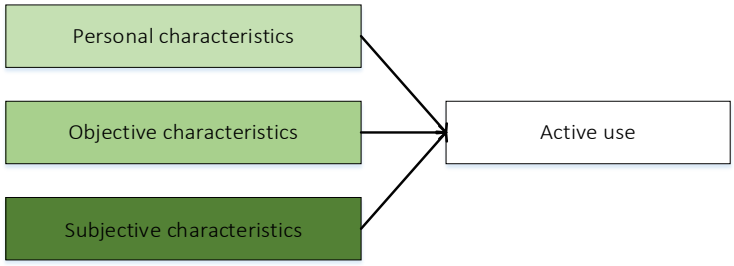

Figure 5.4: Active use

5.5.1. Personal characteristics

Table 5.10 shows the results of the bivariate analyses that have been carried out between personal characteristics and active use of public space. The table shows that significant differences exist between people of different age groups and educational backgrounds and that significant relationships between activities of daily living, bus use and train use and active use are found.

A significant difference can be observed between people of different age groups. A Bonferroni post hoc test is performed to test which groups differ significantly. The test showed that significant differences occur between people of 18 to 35 years old (M=11.094, SD=5.560) and people of 36 to 55 years old (M=8.293, SD=3.353) and the oldest age group (M=7.774, SD=3.142). This shows that people who are between 18 and 35 more frequently use public space for active purposes than people of the two oldest age groups.

Table 5.10: Bivariate analysis Personal characteristics – Active use

Active use				
t-test	*Mean*	*St. Dev.*	*t.*	*Sig.*
Gender			1.026	0.306
Male	9.255	4.415		
Female	8.577	4.076		
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Age			**12.182****	**0.000**
18-35 years	11.094	5.580		
36-55 years	8.293	3.353		
56 years or older	7.774	3.142		
Education			**10.286****	**0.000**
Low	6.981	3.171		
Moderate	7.703	3.461		
High	9.900	4.450		
Income			1.985	0.118
Low	8.269	4.685		
Moderate	8.550	3.709		
High	9.764	4.524		
Unknown	7.290	2.583		
Household composition			1.720	0.182
One-person household	8.551	3.782		
Household without children	9.469	4.765		
Household with children	8.222	3.762		
Pearson's Correlation			*r.*	*Sig.*
Activities of daily living			**-0.181***	**0.010**
Car use as a passenger			0.018	0.799
Car use as a driver			**-0.177***	**0.012**
Bus use			**0.195****	**0.006**
Train use			**0.405****	**0.000**

* Significant at the 0.05 level (2-tailed).

** Significant at the 0.01 level (2-tailed).

Another significant difference is found between education and active use. Again, a Bonferroni post hoc test is performed, which shows that a difference exists between people with a low education (M=6.981, SD=3.171) and people with a high education (M=9.900, SD=4.450) and between people with a moderate (M=7.703, SD=3.461) and a high education. People with a high educational background are thus more likely to actively use public space than people with a moderate or low educational background.

A significant relationship between activities of daily living and active use can also be observed, as is shown in Table 5.10. The negative relationship indicates that people who are more dependent on others in the performance of daily activities are less likely to actively use public space. Three other significant relationships are found between car use as a driver, bus use and train use and active public space use. Two relationships are positive, indicating that people who use the bus or train more frequently are also more likely to actively use public space frequently. However, car use as a driver is negatively related to active use, indicating that people who use the car frequently, use public space less active than people who do not frequently drive a car.

5.5.2. Objective characteristics

Bivariate analyses are performed between the objective characteristic neighbourhood and active public space use, as is shown in Table 5.11. A significant difference is observed between Maaspoort (M=7.686, SD=3.301) and Binnenstad (M=12.685, SD=4.650) and between Binnenstad and Rosmalen Zuid (M=7.793, SD=3.474), as is found after performing the Bonferroni test. People who live in Maaspoort and Rosmalen Zuid are less likely to use public space for active purposes than people who live in Binnenstad. This may be caused by the facilities in the inner city or by the differences in the sample.

Table 5.11: Bivariate analysis Objective characteristics – Active use

Active use				
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Neighbourhood			**30.460****	**0.000**
Maaspoort	7.686	3.301		
Binnenstad	12.685	4.650		
Rosmalen Zuid	7.793	3.474		

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.5.3. Subjective characteristics

Bivariate analyses are done to test significant relationships between subjective neighbourhood characteristics and active use. As is shown in Table 5.12 the perception of walkability significantly affects the active use of public space. The positive relationship indicates that people who think their neighbourhood is walkable, more actively use public space. Neighbourhood attachment and social cohesion were not found to influence active use significantly.

Table 5.12: Bivariate analysis Subjective characteristics – Active use

Active use		
Pearson's Correlation	*r.*	*Sig.*
Neighbourhood attachment	0.125	0.077
Social cohesion	0.070	0.328
Perception of walkability	**0.359****	**0.000**

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.6. Passive use

The fifth component of the principal component analysis is named passive use, which exists of activities such as sitting and watching and gathering outdoors. Figure 5.5 shows the possible relationships between the independent characteristics and passive use. Subsequent sections will present the results of the bivariate analyses that are performed to check which relationships are significant.

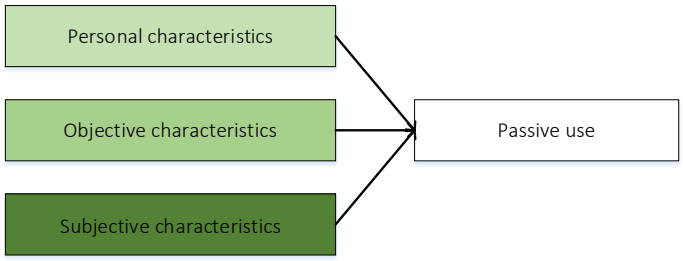

Figure 5.5: Passive use

5.6.1. Personal characteristics

Table 5.13 shows that significant relationships are found between bus use, train use and car use as a driver and passive use. The relationships between bus and train users indicate that passive use of public space is higher among train and bus users. The relationship between car use as a driver and passive use indicates that people who drive a car less often use public space for passive activities. No significant differences in passive use are found between men and women, people of different age groups, people with different educational backgrounds and incomes and people of different household compositions.

Table 5.13: Bivariate analysis Personal characteristics – Passive use

Passive use				
t-test	*Mean*	*St. Dev.*	*t.*	*Sig.*
Gender			0.338	0.736
Male	11.491	4.434		
Female	11.255	4.389		
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Age			0.403	0.669
18-35 years	11.407	4.731		
46-55 years	10.874	4.076		
56 years or older	11.534	4.407		
Education			0.116	0.890
Low	11.290	4.625		
Moderate	11.076	4.296		
High	11.440	4.381		
Income			0.111	0.954
Low	11.631	4.922		
Moderate	11.200	4.009		
High	11.311	4.530		
Unknown	11.054	4.630		
Household composition			1.324	0.268
One-person household	11.879	4.971		
Household without children	11.533	4.250		
Household with children	10.673	4.016		
Pearson's Correlation			*r.*	*Sig.*
Activities of daily living			-0.138	0.051
Car use as a passenger			-0.015	0.837
Car use as a driver			**-0.212****	**0.003**
Bus use			**0.211****	**0.003**
Train use			**0.259****	**0.000**

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.6.2. Objective characteristics

Bivariate analyses are carried out between the neighbourhoods in which respondents live and passive use. Table 5.14 indicates that significant differences exist between people of different neighbourhoods. Again, a post hoc Bonferroni test is used to observe which neighbourhoods differ. The test shows that residents of Binnenstad (M=13.643, SD=4.891) score higher on passive use than residents of Maaspoort (M=10.339, SD=4.004) and Rosmalen Zuid (M=11.465, SD=4.067).

Table 5.14: Bivariate analysis Objective characteristics – Passive use

Passive use				
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Neighbourhood			9.287**	0.000
Maaspoort	10.339	4.004		
Binnenstad	13.643	4.891		
Rosmalen Zuid	11.465	4.067		

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.6.3. Subjective characteristics

Bivariate analyses are also performed between subjective neighbourhood characteristics and passive use, as is shown in Table 5.15. The Pearson's correlations show that all three subjective characteristics are significantly related to passive use. All three relationships are positive, indicating that people who are attached to their neighbourhood, who observe social cohesion and walkability to be high in their neighbourhood, use public space for passive activities more frequently than people who feel less attached or rate the social cohesion and walkability less positively.

Table 5.15: Bivariate analysis Subjective characteristics – Passive use

Passive use		
Pearson's Correlation	*r.*	*Sig.*
Neighbourhood attachment	0.276**	0.000
Social cohesion	0.226**	0.001
Perception of walkability	0.204**	0.004

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.7. Visit green space

The final bivariate analyses are done to test significant relationships between personal characteristics and objective and subjective neighbourhood characteristics and visit green space, as is shown in Figure 5.6. Visit green space exists of the frequency of visits to green spaces such as sport fields and forests.

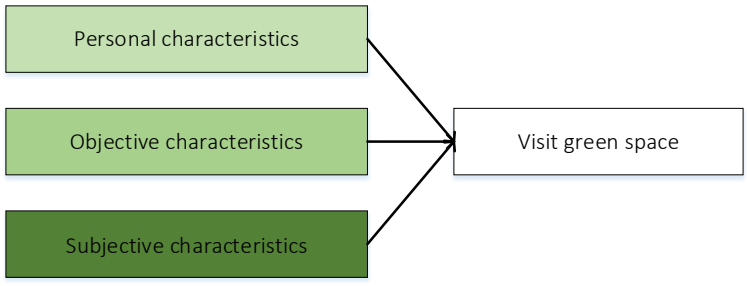

Figure 5.6: Visit green space

5.7.1. Personal characteristics

Four personal characteristics significantly affect green space. The first characteristic is gender. Table 5.16 shows that males score higher on green space visits than females. Secondly, a significant difference between income levels has been observed. A post hoc test is performed to find which income groups differ significantly. The Bonferroni post hoc test shows that people with a moderate income (M=3.373, SD=2.222) score lower on green space visits than people with a high income (M=4.511, SD=2.594).

Another significant difference is observed between people of different household compositions. The post hoc test indicated that people who live alone (one-person households) (M=3.179, SD=1.860) score lower on green space visits than people who live in households without children (M=4.295, SD=2.655).

Finally, a significant relationship is found between activities of daily living and visit green space. The relationship is negative, which indicates that people who are independent of others more often visit green spaces than people who are dependent on others in performing daily activities.

Table 5.16: Bivariate analysis Personal characteristics – Visit green space

Visit green space				
t-test	*Mean*	*St. Dev.*	*t.*	*Sig.*
Gender			**2.558***	**0.011**
Male	4.672	2.586		
Female	3.674	2.415		
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Age			0.559	0.573
18-35 years	4.234	2.685		
36-55 years	3.978	2.707		
56 years or older	3.776	2.266		
Education			1.274	0.282
Low	3.583	2.339		
Moderate	3.688	2.284		
High	4.201	2.633		
Income			**3.242***	**0.023**
Low	3.991	2.681		
Moderate	3.373	2.222		
High	4.511	2.594		
Unknown	4.926	2.427		
Household composition			**3.828***	**0.023**
One-person household	3.179	1.860		
Household without children	4.295	2.655		
Household with children	4.201	2.663		
Pearson's Correlation			*r.*	*Sig.*
Activities of daily living			**-0.156***	**0.028**
Car use as a passenger			0.061	0.393
Car use as a driver			0.032	0.648
Bus use			-0.053	0.460
Train use			0.055	0.439

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.7.2. Objective characteristics

An ANOVA test can be used to test the significance of the relationship between the neighbourhood in which a respondent lives and visit green space. Table 5.17 shows that there is no significant difference in visit green space between people living in the three selected neighbourhoods.

Table 5.17: Bivariate analysis Objective characteristics – Visit green space

Visit green space				
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Neighbourhood			1.768	0.173
Maaspoort	3.644	2.190		
Binnenstad	4.212	2.552		
Rosmalen Zuid	4.370	2.978		

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.7.3. Subjective characteristics

The subjective characteristics neighbourhood attachment, social cohesion and perception of walkability are tested on their influence on visit green space. All three characteristics significantly affect green space visits, as is shown in Table 5.18. People who are attached to their neighbourhood score higher on green space visits. People who indicated the social cohesion and walkability of their neighbourhood to be high also score higher on visit green space, meaning that they more often visit green space than people who are less positive about the social cohesion and walkability of their neighbourhood.

Table 5.18: Bivariate analysis Subjective characteristics – Visit green space

Visit green space		
Pearson's Correlation	*r.*	*Sig.*
Neighbourhood attachment	**0.140***	**0.048**
Social cohesion	**0.213****	**0.002**
Perception of walkability	**0.186****	**0.008**

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.8. Loneliness

After the bivariate analyses that were performed to test the significance of relationships between the independent variables and the mediating variables, in this section the significance is tested of the relationships between the independent variables and loneliness. Figure 5.7 shows the relationships that are expected between these variables. In the continuation of this section t-tests, ANOVA tests and Pearson's correlations are used to test whether relationships are significant. The relationships between the mediating variables and loneliness are also tested in the following sections.

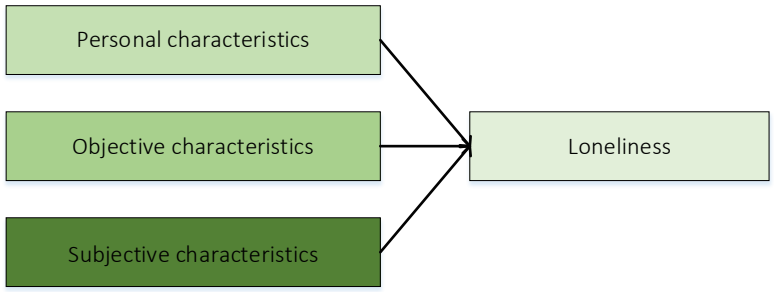

Figure 5.7: Loneliness (independent variables)

5.8.1. Personal characteristics

First, the influence of personal characteristics on the loneliness of respondents is tested, as is shown in Table 5.19. This table shows that gender, household composition and activities of daily living are significantly related to loneliness. The significant difference between gender indicates that females more often feel lonely than males.

Another significant difference is found between household compositions. The Bonferroni post hoc test indicates that a significant difference exists between a one-person household (M=4.464, SD=1.684) and households without children (M=3.375, SD=0.846). Another significant difference is observed between one-person households and households with children (M=3.764, SD=1.316). People who live alone (one-person households) feel lonelier than people who live in households with or without children.

Thirdly, a Pearson's correlation is used to test relationships between activities of daily living and different transport modes. Table 5.19 shows that a significant relationship is found between activities of daily living and loneliness. The relationship is positive, indicating that people who are more dependent on others in their performance of daily activities more often feel lonely than people who are not dependent on others.

Table 5.19: Bivariate analysis Personal characteristics – Loneliness

Loneliness				
t-test	*Mean*	*St. Dev.*	*t.*	*Sig.*
Gender			**-3.238****	**0.001**
Male	3.418	0.875		
Female	3.969	1.475		
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Age			0.415	0.661
18-35 years	3.867	1.508		
36-55 years	3.916	1.416		
56 years or older	3.723	1.200		
Education			0.788	0.456
Low	4.049	1.516		
Moderate	3.816	1.349		
High	3.736	1.304		
Income			2.051	0.108
Low	4.244	1.479		
Moderate	3.675	1.389		
High	3.678	1.181		
Unknown	3.923	1.320		
Household composition			**11.269****	**0.000**
One-person household	4.464	1.684		
Household without children	3.375	0.846		
Household with children	3.764	1.316		
Pearson's Correlation			*r.*	*Sig.*
Activities of daily living			**0.278****	**0.000**
Car use as a passenger			-0.134	0.058
Car use as a driver			-0.134	0.059
Bus use			-0.101	0.154
Train use			-0.074	0.296

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.8.2. Objective characteristics

An ANOVA test is performed to check whether people of different neighbourhoods feel lonely. Table 5.20 shows that the neighbourhood in which people live does not affect the extent to which people feel lonely, meaning that there is no difference in loneliness feelings between residents of Maaspoort, Binnenstad and Rosmalen Zuid.

Table 5.20: Bivariate analysis Objective characteristics – Loneliness

Loneliness				
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Neighbourhood			0.963	0.384
Maaspoort	3.710	1.236		
Binnenstad	4.048	1.592		
Rosmalen Zuid	3.863	1.400		

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.8.3. Subjective characteristics

The relationships between subjective characteristics and loneliness are tested by the Pearson's correlation, as is shown in Table 5.21. This table indicates that social cohesion and the perception of walkability both significantly affect the loneliness of respondents. People who reported social cohesion to be high, are less likely to feel lonely than people who are negative about the social cohesion in the neighbourhood. People who reported the walkability to be high are also less likely to feel lonely than people who indicated the walkability of a neighbourhood to be lacking.

Table 5.21: Bivariate analysis Subjective characteristics – Loneliness

Loneliness		
Pearson's Correlation	*r.*	*Sig.*
Neighbourhood attachment	-0.079	0.265
Social cohesion	**-0.266****	**0.000**
Perception of walkability	**-0.149***	**0.035**

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.8.4. Use of public space

After the bivariate analyses between the independent variables and loneliness, the mediating variables are tested on their influence on loneliness. Figure 5.8 shows the six components of use of public space, which were found after principal component analysis, and their possible relationships with loneliness. Table 5.22 shows that two components of use of public space significantly affect the loneliness of people. Passive use and visit green space are significantly related to loneliness. People who visit green space or use public space for passive activities frequently, less often feel lonely.

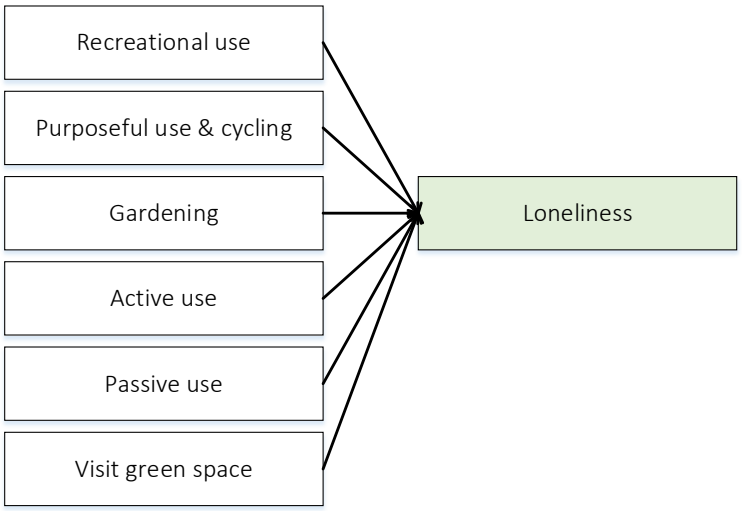

Figure 5.8: Loneliness (use of public space)

Table 5.22: Bivariate analysis Use of public space – Loneliness

Loneliness		
Pearson's Correlation	*r.*	*Sig.*
Recreational use	-0.117	0.100
Purposeful use and cycling	-0.128	0.070
Gardening	-0.098	0.167
Active use	-0.117	0.100
Passive use	**-0.186****	**0.008**
Visit green space	**-0.174***	**0.014**

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.9. Life satisfaction

For the second dependent variable, life satisfaction, bivariate analyses are used to test the relationships between personal characteristics and objective and subjective neighbourhood characteristics. Figure 5.9 shows the relationships that are tested on their significance.

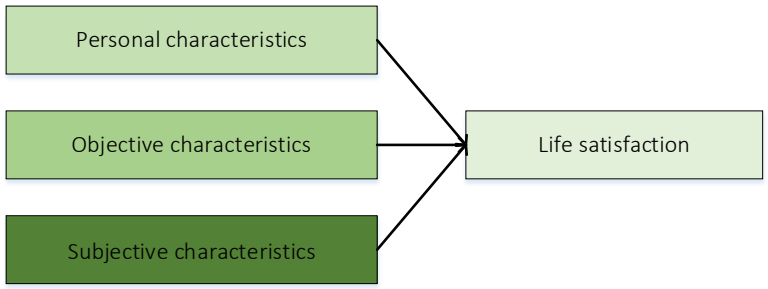

Figure 5.9: Life satisfaction (independent variables)

5.9.1. Personal characteristics

Table 5.23 shows that t-tests, ANOVA tests and Pearson's correlations are used to test the significance of relationships between personal characteristics and life satisfaction. Two significant relationships are found. Firstly, a significant difference can be observed between people of the three household compositions. The Bonferroni post hoc test indicated that a significant difference in the satisfaction of life can be observed between one-person households (M=16.661, SD=4.231) and households with children (M=18.944, SD=4.107). Moreover, a significant difference occurs between one-person households and households with children (M=18.903, SD=3.481). People who live alone are thus more likely to be dissatisfied with their life than people who live together, with or without children.

A second significant relationship is found between activities of daily living and life satisfaction, as is shown in Table 5.23. The negative relationship indicates that people who are able to perform activities of daily life independently are more satisfied with their life than people who need help in performing these activities.

Table 5.23: Bivariate analysis Personal characteristics – Life satisfaction

Life satisfaction				
t-test	*Mean*	*St. Dev.*	*t.*	*Sig.*
Gender			0.667	0.505
Male	18,600	3.952		
Female	18,172	4.081		
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Age			0.319	0.727
18-35 years	18.548	4.324		
36-55 years	18.466	3.942		
56 years or older	18.051	3.955		

Life satisfaction				
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Education			1.796	0.169
Low	17.366	3.935		
Moderate	18.082	4.030		
High	18.727	4.054		
Income			1.364	0.255
Low	17.267	3.881		
Moderate	18.410	4.223		
High	18.797	4.438		
Unknown	18.769	4.041		
Household composition			**6.686****	**0.002**
One-person household	16.661	4.231		
Household without children	18.944	4.107		
Household with children	18.903	3.481		
Pearson's Correlation			*r.*	*Sig.*
Activities of daily living			**-0.286****	**0.000**
Car use as a passenger			0.072	0.310
Car use as a driver			0.100	0.161
Bus use			0.082	0.249
Train use			0.045	0.523

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.9.2. Objective characteristics

The ANOVA test is used to test whether the life satisfaction of people differs between the three neighbourhoods in which respondents live. Table 5.24 shows that the differences between the neighbourhoods are not significant, indicating that the life satisfaction of respondent is not dependent on the residential location of people.

Table 5.24: Bivariate analysis Objective characteristics – Life satisfaction

Life satisfaction				
ANOVA	*Mean*	*St. Dev.*	*F.*	*Sig.*
Neighbourhood			0.346	0.708
Maaspoort	18.505	3.758		
Binnenstad	18.143	4.942		
Rosmalen Zuid	17.961	3.847		

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.9.3. Subjective characteristics

Table 5.25 shows the results of the Pearson's correlations between neighbourhood attachment, social cohesion, perception of walkability and life satisfaction. Social cohesion and the perception of walkability both significantly affect life satisfaction. People who are positive about the social cohesion in their neighbourhood are more satisfied with their life. The same holds for the perception of walkability in a neighbourhood. People who are positive about the walkability are more satisfied with their life than people who think the walkability of the neighbourhood is lacking.

Table 5.25: Bivariate analysis Subjective characteristics – Life satisfaction

Life satisfaction		
Pearson's Correlation	*r.*	*Sig.*
Neighbourhood attachment	0.003	0.966
Social cohesion	**0.260****	**0.000**
Perception of walkability	**0.201****	**0.004**

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.9.4. Use of public space

After the bivariate analyses between the independent variables and life satisfaction, the possible relationships between the mediating variables and life satisfaction are tested. Figure 5.10 shows the relationships that may occur. Table 5.26 shows that there are two significant relationships between the components of use of public space and life satisfaction. These components are active use and visit green space. The positive relationships which are found with the Pearson's correlation, indicate that people who visit green space or are active in public space, are more satisfied with their life than people who are not as active or who do not visit green space frequently.

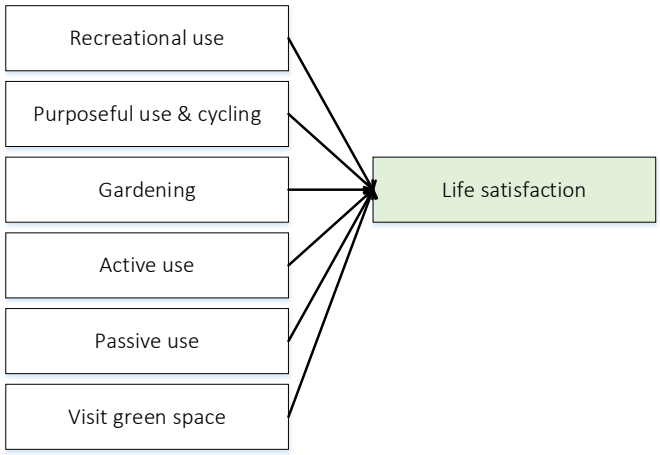

Figure 5.10: Life satisfaction (use of public space)

Table 5.26: Bivariate analysis Use of public space – Life satisfaction

Life satisfaction		
Pearson's Correlation	*r.*	*Sig.*
Green space use	0.083	0.240
Social/ green space use	0.097	0.173
Gardening	0.038	0.589
Active use	**0.181***	**0.010**
Passive use	0.075	0.293
Visit green space	**0.191****	**0.007**

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.9.5. Loneliness

Finally, a relationship is expected between loneliness and life satisfaction, as is shown in Figure 5.11. The Pearson's correlation is used to test whether this relationship is significant. Table 5.27 shows that the relationship is significant and negative. People who feel lonely are less satisfied with their life, but people who feel dissatisfied may also feel lonelier.

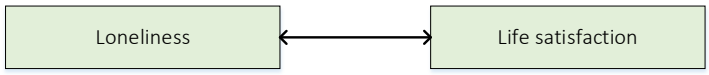

Figure 5.11: Life satisfaction (loneliness)

Table 5.27: Bivariate analysis Loneliness – Life satisfaction

Life satisfaction		
Pearson's Correlation	*r.*	*Sig.*
Loneliness	**-0.401****	**0.000**

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

5.10. Conclusion

The bivariate analyses that have been carried out between the personal characteristics, objective and subjective neighbourhood characteristics and public space use and loneliness and life satisfaction, result in significant and insignificant relationships. Figure 5.12 shows the conceptual model after performing the bivariate analyses. The analyses showed that gardening is not significantly related to any of the other variables and is therefore deleted from the model. Five mediating variables remain after principal component analysis and deleting gardening.

The bivariate analyses that were performed for the sample showed that gender, household composition, activities of daily living, social cohesion, perception of walkability, passive use and visit green space are significantly related to loneliness. For life satisfaction a significant influence of household composition, activities of daily living, social cohesion, perception of walkability, active use and visit green space was observed. The significant relationships will be used in the path analysis that will be performed in the next chapter.

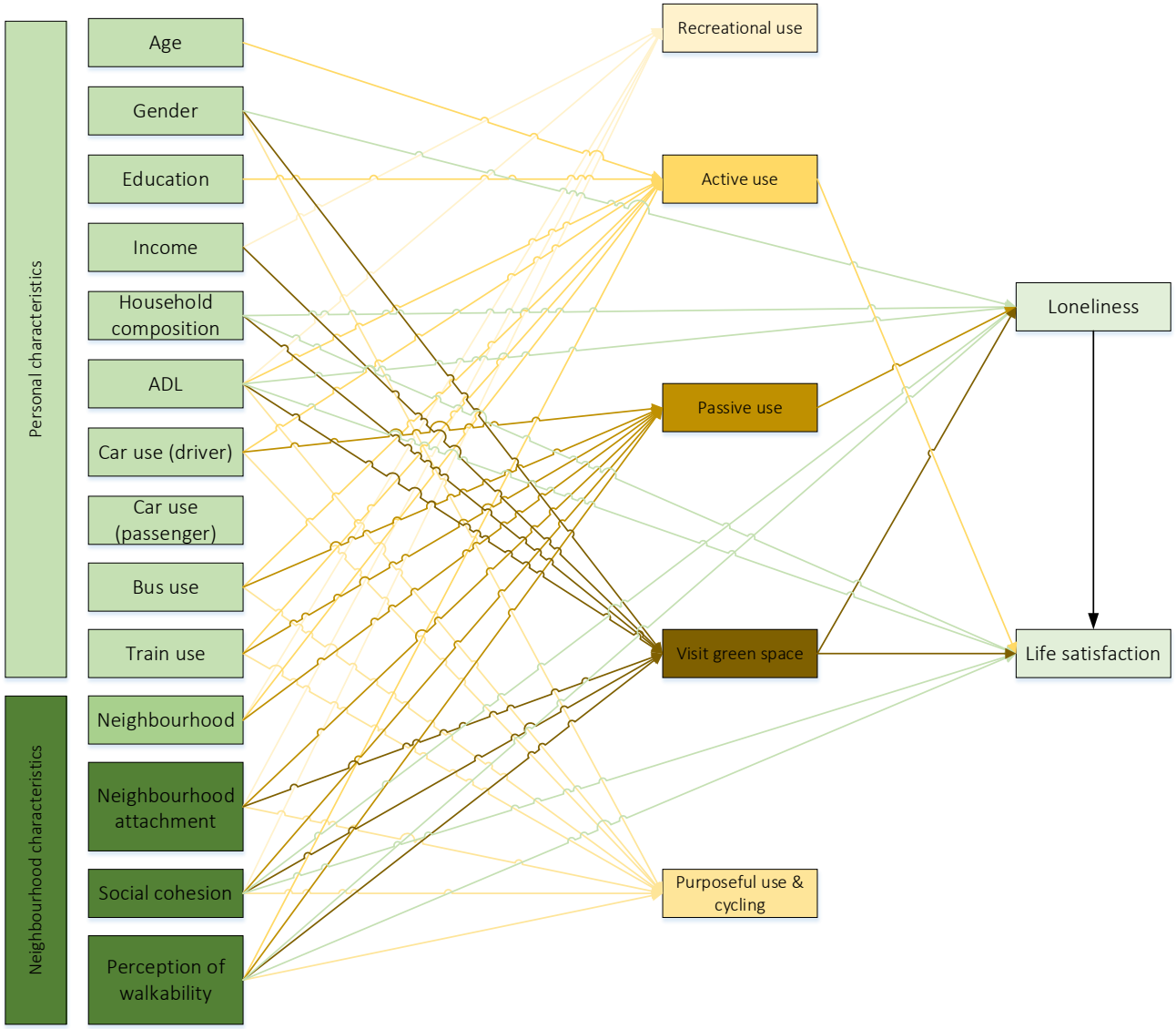

Figure 5.12: Conceptual model after bivariate analyses

6. Path Analysis

In previous chapters, the sample has been described for the personal, objective and subjective neighbourhood characteristics. In chapter 5 bivariate analyses were carried out, to observe which relationships from the conceptual model are significant and should be used in the path analysis. In the path analysis, the relationships that were significant in bivariate analyses, are tested on their significance when they are estimated simultaneously. The relationships that are insignificant are deleted step-by-step to optimize the final path model.

6.1. Path analysis

The analytical approach that is chosen to analyse the effects of personal characteristics and subjective and objective neighbourhood characteristics on public space use, loneliness and life satisfaction, is path analysis. The advantage of using path analysis over bivariate or regression analysis, is that multiple relationships between independent and dependent variables can be analysed simultaneously. Path analysis is a special case of structural equation modelling, in which only observed variables are used (van den Berg & Timmermans, 2015). The path model was estimated using the statistical package LISREL version 8.54.

In the previous chapter bivariate analyses have been performed, based on the relationships in the conceptual model. To prepare the variables for path analysis, categorical variables are recoded into dummy variables. Then, all significant relationships that were observed in the bivariate analyses are added to the path model. To reduce the number of variables in the path analysis and to overcome the risk of overfitting the model, the relationships that were not found to be significant at the 0.1 ($t \geq 1.65$) significance level in the path model were removed. The backward stepwise process was repeated until an acceptable model fit was found and all insignificant relationships were removed from the model.

Table 6.1 shows the goodness of fit of the final model. The Chi-Square statistic should be insignificant, because Chi-Square measures the difference between the observed variance and the expected variance. If the Chi-Square is insignificant, the difference between observed and expected variance is not due to variation in the sample. Chi-Square can also be used to measure the goodness of fit of the model. Chi-Square divided by the degrees of freedom should ideally be smaller than 2 but smaller than 5 is also acceptable (Stassart, Hansez, Delvaux, Depauw, & Etienne, 2013). In case of the current path analysis, Chi-Square is 2.5 times larger than the degrees of freedom.

The Root Mean Square Error of Approximation (RMSEA) should ideally equal 0. Values below 0.05 are generally accepted as a good fit of the model to the data (Golob, 2001). In the current path analysis, RMSEA equals 0.089, which is a modest fit. This may be due to a high number of paths in comparison to a relatively small sample (Taasoobshirazi & Wang, 2016). The Goodness of Fit Index equals 0.91 and should preferably be greater than 0.90 to indicate a good model (Golob, 2001).

Table 6.1: Goodness of fit

Degrees of freedom	100
Full Information ML Chi-Square	254.02
RMSEA (Root Mean Square Error of Approximation)	0.089
90 Percent Confidence Interval for RMSEA	0.075;0.10
P-value for Test of Close Fit (RMSA<0.05)	0.0000
Goodness of Fit Index	0.91

6.2. Relationships with public space use, loneliness and life satisfaction

This section describes the significant relationships between the explanatory variables and the dependent variables of public space use, which arose after principal component analysis. The relationships between the explanatory variables and loneliness and life satisfaction will also be discussed. Finally, the relationship between loneliness and life satisfaction will be explained. Table 6.2 and Figure 6.1 show the significant relationships in the path model at the 0.05 and 0.1 significance levels. In Figure 6.1 the significant positive relationships are drawn with a black arrow and negative relationships with a dashed black arrow.

6.2.1. Recreational use

Recreational use can be explained as the frequency of visits to public space for leisure activities, such as walking. The first predictor of recreational use is **age**. When residents are older, they are found to use public spaces for recreational purposes more often. Previous findings have shown that residents who are aged above 55 more frequently visit public spaces than people who are aged between 35 and 55. The explanation for this finding is that middle-aged residents more often are full-time employed and travel outside their neighbourhood on a daily basis. Middle-aged residents are therefore also more likely to use public spaces outside their neighbourhood (Kaczynski, Potwarka, Smale, & Havitz, 2009).

A significant relationship between **activities of daily living** (ADL) and recreational space use is also found. People with a lower ADL less often use public space for recreational activities than people with a high ADL. Although this relationship has not been found in previous studies, research did show that residents with functional limitations walk significantly less for recreational purposes than residents without functional limitations (van Cauwenberg, et al., 2015). In general, people with functional limitations reported to have fewer places to go for a walk and were more negative about neighbourhood facilities (Bowling & Stafford, 2007).

Another significant association exists between **neighbourhood** and recreational use. Residents of Binnenstad and Maaspoort more frequently use public space for recreational purposes than residents of Rosmalen Zuid. In previous chapters, it is shown that the maintenance of public spaces in Binnenstad and Maaspoort is higher than the maintenance of public space in Rosmalen Zuid. Previously, it has been argued that well-maintained public spaces are visited most frequently (Yung, Ho, & Chan, 2017).

Neighbourhood attachment also significantly affects recreational use. Residents who feel attached to their neighbourhood more often use public space for recreational activities. This could be because residents who feel attached, generally, are more familiar and have more social contacts in the neighbourhood. As was argued before, having social contacts in the neighbourhood invites people to use public space more often (Francis, Giles-Corti, Wood, & Knuiman, 2012; Zhang & Zhang, 2017). The motivation to spend time outdoors is higher among residents who are attached to their neighbourhood (Moulay, Ujang, Maulan, & Ismail, 2018).

6.2.2. Purposeful use & cycling

Purposeful use and cycling has been explained as the frequency of visits to green spaces for specific purposes. Purposeful use and cycling is found to be associated with **train use**. People who frequently use the train are more likely to use public space for specific purposes or to cycle in the neighbourhood. Frequent train users may walk more to reach train stations, thereby walking through public space. It could also be that both train use and public space use demands users to have a certain level of functional capability. People who can use the train, may have higher ability to use public space for specific purposes or to cycle in the neighbourhood. To the best of the author's knowledge, previous studies have not found this relationship.

The path analysis also showed that the **neighbourhood** significantly affects purposeful use and cycling. Residents of Maaspoort and Binnenstad more often use public space for specific purposes or for cycling than residents of Rosmalen Zuid. In Binnenstad, a larger number of facilities and services can be found within a small distance. In Maaspoort, the area of land covered with green space is larger than in the other two neighbourhoods. People who live close to facilities and green spaces are expected to be more likely to use public space frequently. Several researchers found that living near green spaces and parks invites people to use public space for recreational activities and for physical activity (van Cauwenberg, et al., 2015; Kaczynski, Potwarka, Smale, & Havitz, 2009).

Another significant relationship can be found between **social cohesion** and purposeful use of public space and cycling. Residents of socially cohesive neighbourhoods more frequently use public space for specific purposes or for cycling. It could be that people who are satisfied with the social cohesion in the neighbourhood use public space for their social contacts. Large public spaces that support various activities, such as sports, play and relaxation, invite residents to use the space and to have social interactions with neighbours (Ayala-Azcárraga, Diaz, & Zambrano, 2019). According to Hadavi and Kaplan (2016) a lack of social cohesion is one the main barriers to use public space.

The **perception of walkability** in a neighbourhood also influences purposeful use and cycling. Residents who perceive the walkability of their neighbourhood to be low are less likely to use public space for specific purposes or for cycling. This finding is confirmed by the finding of Hadavi and Kaplan (2016), who argue that, next to a lack of social cohesion, a lack of walkability limits residents in their use of public space. Walkable green streets in a neighbourhood induce residents to go outside and to walk (Takano, Nakamura, & Watanabe, 2002).

6.2.3. Active use

Active use, existing of activities such as running, is significantly affected by **education**. Residents with a high educational level use public space for active purposes more frequently than people with a low or middle education. It may be that higher educated residents are more aware of the health benefits of an active lifestyle and may therefore use public space more actively. Several researchers studied the relationship between education and public space use and found that highly educated residents prefer to use public space for active purposes, such as sporting and other physical activities (Kemperman & Timmermans, 2006; Toftager, et al., 2011; Giles-Corti & Donovan, 2002).

Train use is also associated with active use. People who frequently use the train are found to use public space for active purposes more often. As was also argued for the relationship between train use and purposeful use and cycling, people who frequently use the train may have fewer physical limitations and may therefore be able to use both the train and public space for active purposes. This relationship has not been observed in previous research.

Another significant association can be observed between **neighbourhood** and active use. Residents of Binnenstad use public space for active purposes more frequently than residents of Maaspoort and Rosmalen Zuid. The high number of facilities and services within a short distance from the residential location induces residents to walk within their neighbourhood, thereby being physically active. Koohsari et al. (2015) conclude that public space is often used to walk through to reach destinations, such as shops and parks.

A significant relationship is also found between the **perception of walkability** and active space use. Residents of highly walkable neighbourhoods are more likely to be frequently active in public space than residents of low walkable neighbourhoods. Van Dyck et al. (2013) also finds that neighbourhood walkability contributes to more active public space use.

6.2.4. Passive use

Passive use can be described as the frequency of passive activities in public space, such as sitting and gathering outdoors. Passive use is influenced by the **activities of daily living**. This indicates that residents who are dependent on others in performing activities of daily living less frequently use public space for passive activities. Due to physical limitations, residents are probably not able to reach public spaces independently and can, therefore, not use them in any form. Xie et al. (2018) also found that residents with limited independence have lower levels of mobility and, therefore, have fewer options to visit public space.

Another significant relationship exists between **car use as a driver** and passive use. The relationship is negative, which indicates that frequent car drivers less often passively use public space. The positive relationships between train use and purposeful use and cycling and active use showed that public transport users are more likely to be active in public space. While public transport users usually have to walk to train or bus stations, car drivers can immediately get into their car without having to walk. This may be an important explanation of the lower frequency of public space use among car drivers compared to train users. The finding that public transport users walk significantly more than private transport users has been confirmed by previous research (Vich , Marquet, & Miralles-Guasch, 2019).

A significant association has also been found between **neighbourhood** and passive use. Residents of Binnenstad use public spaces for passive activities more frequently than residents of the other two neighbourhoods. Again, the high number of facilities and services within a short distance from the residence in the inner city may invite people to use public space for passive purposes.

Another relationship exists between **neighbourhood attachment** and passive use. Public space is more often used for passive activities when residents are attached to their neighbourhood. **Social cohesion** is also found to be associated with passive use. Residents of socially cohesive neighbourhoods visit public spaces for passive purposes more often than residents of neighbourhoods with weaker social cohesion. These findings cannot be confirmed by previous research.

6.2.5. Visit green space

A significant relationship between **income** and the frequency of green space visits is found. People with a high net monthly income visit green spaces more frequently than people with a low or moderate income. Although the effect has previously not been studied on a personal level, previous research did show that residents of high-income neighbourhoods have more opportunities to use green space than residents of low-income neighbourhoods (Astell-Burt, Feng, Mavoa, Badland, & Giles-Corti, 2014).

The **household composition** of residents also affects the frequency of visits to green space. Couples with and without children are observed to visit green spaces more frequently than single persons. Green spaces can provide opportunities for children to play and for parents and other adults to meet with neighbours. Previous studies show a general tendency of young families who expect children or who have children to move to family houses close to nature (Haase, Lautenbach, & Seppelt, 2010; Raymond, Gottwald, Kuoppa, & Kyttä, 2016).

Next to the personal characteristics that influence green space visits, a significant influence of **neighbourhood attachment** on visit green space is found. Residents who are attached to their neighbourhood more frequently visit green spaces. **Social cohesion** also affects the frequency of visits to green space. Residents of socially cohesive neighbourhoods are more likely to visit green spaces frequently. To the best of the author's knowledge, the effects of neighbourhood attachment and social cohesion on visit green space have not been studied before. Previously, the effect of the availability of green space on social cohesion and neighbourhood attachment has mainly be discussed (Maas, van Dillen, Verheij, & Groenewegen, 2009; Peters , Elands, & Buijs, 2010).

Finally, the **perception of walkability** significantly affects green space visits. Residents who live in walkable neighbourhoods more often visit green spaces than residents who live in weaker walkable neighbourhoods. The relationship between walkability and active space use has been found in previous studies (van Dyck, et al., 2013) However, the relationship between walkability and green space visits has not been studied yet.

6.2.6. Loneliness

Next to the associations with the five components of public space use, significant associations with loneliness are found in the path analysis. **Household composition** significantly affects the loneliness of residents. Single persons are found to be lonelier than couples with or without children. Dykstra et al. (2005) also found that people who live alone or who recently lost their partner report to feel lonely.

Another significant relationship exists between **activities of daily living** and loneliness. People who are dependent on others in performing ADL feel lonelier than people who are not dependent on others. A significant effect of age on loneliness has not been found. An ANOVA test (F=6.007, p-value=0.003) shows that the dependence on others increases with age (for 18-35 years old M=19.06, SD=4.388, for 36-55 years old M=20.81, SD=8.55, for 56 years or older M=24.04, SD=10.37). This means that differences in loneliness between age groups are mediated by differences in ADL. Several researchers found comparable results; people who experience difficulties in performing daily activities generally feel lonelier (Dykstra, van Tilburg, & De Jong Gierveld, 2005; Hacihasanoglu, Yildirim, & Karakurt, 2012).

Next to two personal characteristics, the neighbourhood characteristic **social cohesion** is found to affect the loneliness of residents. People who report social cohesion to be low more often feel lonely than residents of socially cohesive neighbourhoods. Nyqvist et al. (2016) also argue that weaker reported social cohesion, weaker sense of belonging and infrequent neighbourhood contacts are significantly related to higher levels of loneliness.

Passive use also significantly affects loneliness, indicating that people who frequently use public space for passive activities are less likely to report loneliness. As can be observed in the path model of Figure 6.1, only one of the five components of public space use is significantly related to loneliness. The relationship between public space use and loneliness is weaker than expected, which may be due to the focus on the frequency of use of public space, instead of a focus on the distance to or quality of public space. For instance, Maas et al. (2009) found that less green spaces in people's living environment coincides with feelings of loneliness.

6.2.7. Life satisfaction

For life satisfaction, four factors were found to be influential. **Activities of daily living** (ADL) significantly affect life satisfaction. Residents who can perform ADL independently are more likely to be satisfied with their life. These findings are confirmed by a previous research that also indicated the effect of declining ADL on life satisfaction. A decrease in ADL causes a reduction in the movement of the individual, the chance to participate in social activities and in the variety of activities of daily living, resulting in a declining life satisfaction (Sato Susumu, Demura, Kobayashi, & Nagasawa, 2002).

Another significant relationship can be observed between **social cohesion** and life satisfaction, indicating that people who live in socially cohesive neighbourhoods are more likely to be satisfied with their lives. Delhey and Dragalov (2016) confirm this finding and argue that people who live in socially cohesive neighbourhoods are more optimistic about their future and more positive about the purpose of their lives, resulting in higher satisfaction with life.

Next, **active use** significantly affects life satisfaction. Residents who frequently use public space for active purposes are more satisfied with their life than residents who do not frequently actively use public space. The effect of active use on life satisfaction has not been studied before, although several researchers did indicate that residents who live close to green space are more satisfied with their life (Ambrey & Fleming, 2014; Krekel, Kolbe, & Wüstemann, 2016).

A significant relationship also exists between **loneliness** and life satisfaction. Residents who feel lonely reported lower satisfaction with their life than residents who do not feel lonely. Borg et al. (2008) also finds that loneliness is significantly related to life satisfaction.

6.3. Conclusion

This chapter showed the significant relationships that exist between personal and neighbourhood characteristics and public space use on the one hand and loneliness and life satisfaction on the other hand. As is shown in Figure 6.1 and Table 6.2 significant relationships between personal and neighbourhood characteristics and loneliness and life satisfaction are found, but a limited effect of public space use on loneliness and life satisfaction is observed. The insignificance of these relationships may be caused by the orientation towards frequency of use of public space, instead of a focus on distance to or quality of public space. Although the effect of frequency of public space use on loneliness and life satisfaction is limited, significant relationships between personal and neighbourhood characteristics and the five uses of public space have also been observed. In addition, some relationships between personal and neighbourhood characteristics and loneliness and life satisfaction are found to exist. This indicates that public spaces, to some extent, do affect people's life satisfaction and loneliness.

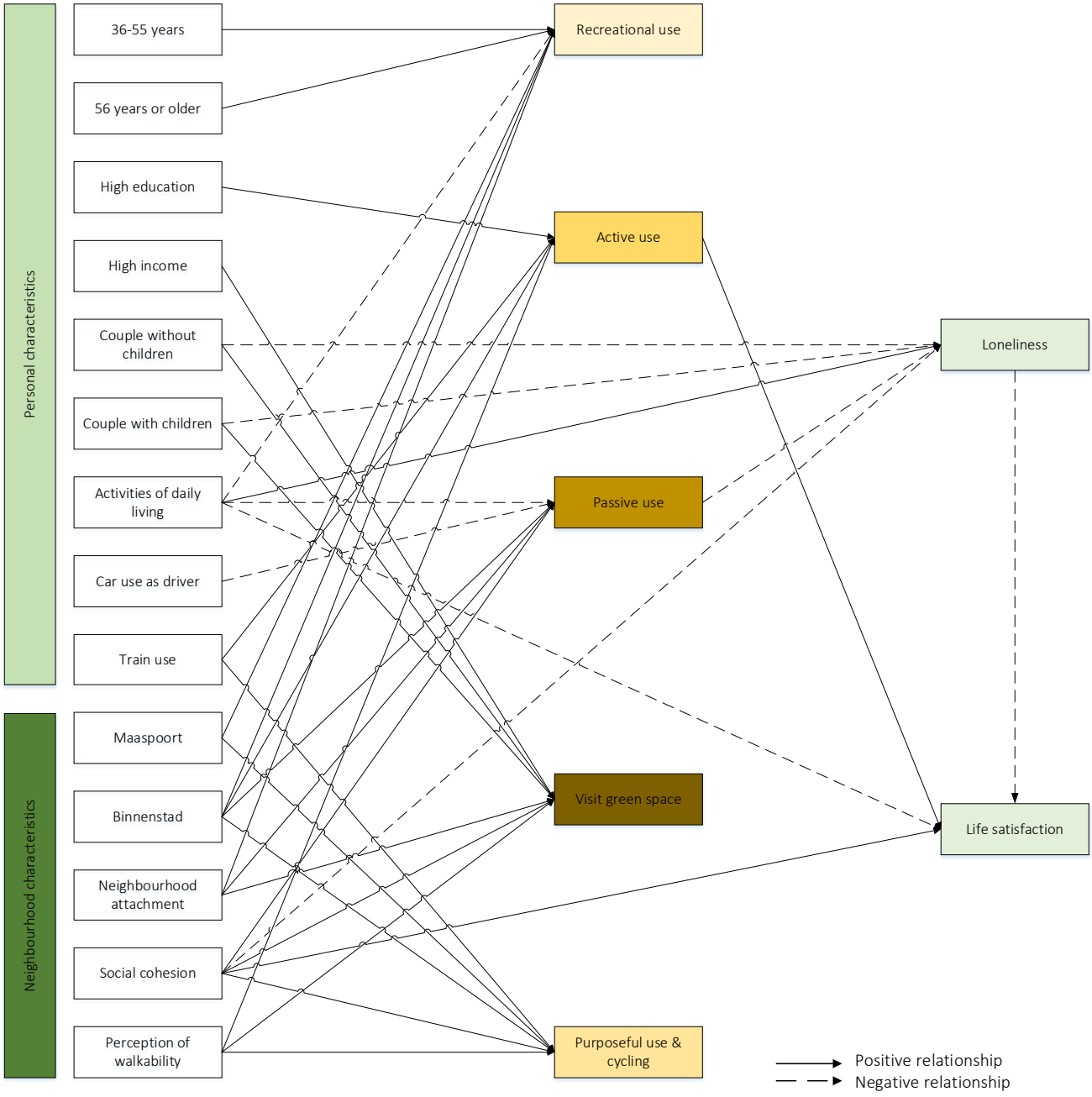

Figure 6.1.: Relationships in path model

Table 6.2: Results path analysis

		Life satisfaction	Loneliness	Recreational use	Purposeful use and cycling	Active use	Passive use	Visit green space
Variables	Categories	Unstandardized coefficients						
Age	18-35	-	-	-	-	-	-	-
	36-55			4.31**				
	56 or above			3.39**				
Education	Low					-0.63		
	Moderate	-	-	-	-	-	-	-
	High					1.02*		
Income	Low							0.65
	Moderate	-	-	-	-	-	-	-
	High							1.00**
	Unknown	-	-	-	-	-	-	-
Household composition	One-person household	-	-	-	-	-	-	-
	Household without children		-0.87**					0.88*
	Household with children		-0.55**					1.04**
Activities of daily living		-0.07**	0.03**	-0.18**			-0.10**	
Car use as a driver							-0.48**	
Train use					0.82*	0.62**		
Neighbourhood	Maaspoort			4.68**	1.75*	-0.46	-1.16	
	Binnenstad			5.69**	4.75**	3.40**	1.58*	
	Rosmalen Zuid	-	-	-	-	-	-	-
Neighbourhood attachment				0.38**			0.14**	0.07*
Social cohesion		0.12**	-0.04**		0.27**		0.18**	0.08**
Perception of walkability					0.48**	0.25**		0.11*
Recreational use								
Purposeful use and cycling								
Active use		0.10*						
Passive use			-0.04*					
Green space								
Loneliness		-0.93**						
R-Squared		0.22	0.19	0.20	0.29	0.39	0.23	0.16

7. Conclusion, discussion and recommendations

7.1. Conclusion

The aim of this study was to provide insights into the personal and neighbourhood characteristics that are related to the use of public space on the one hand and loneliness and life satisfaction of residents on the other hand. The relationships between use of public space and loneliness and life satisfaction were also studied, as well as the relationship between loneliness and life satisfaction. The lack of accessible, high-quality public spaces for all residents of our rapidly ageing and urbanizing society, is one of the main challenges that urban planners and managers face. Especially in these urbanized environments, public spaces where residents can relax, recreate and escape from their daily lives, are increasingly important and needed.

In order to provide insights into the expected relationships with public space use, loneliness and life satisfaction, a literature review was conducted, leading to a conceptual model. In the conceptual model expected relationships were drawn, which formed the basis for the analyses. To test the conceptual model, data were collected by using a cross-sectional approach. In total, 200 useful responses to the questionnaire were collected, which could be used for further analysis. Data were analysed in two steps. Firstly, bivariate analyses were conducted to eliminate relationships in the conceptual model that were not significant. In the second step, a path analysis was performed to investigate the significant predictors of public space use, while simultaneously observing the relationships with loneliness and life satisfaction. This approach has resulted in the following findings.

Five uses of public space were distinguished: recreational use, purposeful use and cycling, active use, passive use and visits to green space. These components were the result of a principal component analysis on the three activities: the frequency of walking or cycling, the frequency of use of specific spaces and the frequency of specific activities. Recreational use refers, for instance, to the use of parks and green areas for leisure activities, whereas purposeful use and cycling refers to activities that are performed in public space with a specific purpose. In addition, active space use refers to activities such as running and passive space use refers to sitting and gathering outdoors in public space. Personal characteristics that were found to influence any of the five uses of public space are age, education, income, household composition, activities of daily living, car use as a driver and train use. Age was only found to significantly affect recreational space use, indicating that older residents more often use public space for recreational purposes than younger residents. In the current study, no significant influence of age on loneliness or life satisfaction was found. In contrast, activities of daily living (ADL) were found to affect loneliness and life satisfaction. An ANOVA test showed that differences in loneliness and life satisfaction between age groups were mediated by differences in ADL. The level of independence of people to perform certain activities is therefore believed to be one of the main contributors to loneliness, life satisfaction and frequency of use of public space.

Other personal characteristics that were found to be related to public space use are educational background, income and household composition. Higher educated residents indicated to use public space more actively than lower educated residents. People with a high income were, in addition, found to be more likely to visit green spaces. Couples with or without children more often visit green spaces than single persons. Couples were also found to be less likely to feel lonely than single persons. Public spaces can provide opportunities for children to play and for parents and other adults to meet with neighbours. Social interactions that exist between parents and other neighbours in public space may also reduce the risk of feeling lonely. However, more in-depth research is needed to explain the relationships between household composition, income, educational background and public space use and loneliness.

Results of the path analysis also indicated that frequent train users are more likely to use public space for specific purposes and cycling and active purposes. These results indicate that public transport users are, in general, more physically active than people who use other transport modes, such as the car. It could, therefore, be argued that the availability of public transport facilities within walking distance invites residents to use them and to reduce their car use.

The perception of walkability was also found to be related to purposeful use and cycling, active use and green space visits. Residents who perceived their neighbourhood to be walkable, are more likely to use public space for these activities. It could be that these residents also meet physical activity recommendations easier, since they walk significantly more than residents of unwalkable neighbourhoods. Previously, it was argued that living in highly walkable neighbourhoods invites people to go outside and to meet neighbours in public space. It could therefore also be that highly walkable neighbourhoods support public space use as well as the social interactions between neighbours.

Social cohesion and neighbourhood attachment played a major role in the use of public space and the extent to which residents feel lonely or satisfied with their life. As was shown in the path analysis, social cohesion is significantly related to purposeful use and cycling, passive use and green space visits. In addition, neighbourhood attachment is related to recreational use, passive use and green space visits. Social cohesion is also significantly related to loneliness and life satisfaction. People who live in socially cohesive neighbourhoods or feel attached to the neighbourhood are thus more likely to go outside and use public space. These residents are also more likely to feel satisfied with life and are less likely to feel lonely. Again, public spaces provide opportunities for social interactions with neighbours, which could lead to a stronger connection with these spaces. Although these relationships were not studied before, previous studies did indicate that the use of public space increases the social cohesion in the neighbourhood and attachment to the neighbourhood of residents. Previous studies also showed that residents of socially cohesive neighbourhoods are less prone of becoming lonely.

7.2. Policy implications

This study showed that public space use is significantly affected by both personal and neighbourhood characteristics. These characteristics as well as public space use significantly affected loneliness and life satisfaction. These results have implications for various stakeholders, such as municipalities, urban planners and developers of public space. The extent to which residents can perform activities of daily living independently, affected not only their use of public space but also their loneliness and life satisfaction. To promote independence among residents and ageing in place among elderly, supportive neighbourhoods with high-quality, accessible public spaces should be designed that help to increase public space use, reduce loneliness and increase life satisfaction of residents.

Moreover, policy makers should aim to create neighbourhoods that are highly walkable, where people are invited to go outside and to meet their neighbours. As was shown in this research, residents of walkable neighbourhoods use public space more active and may therefore meet physical activity recommendations more easily. In general, public spaces in cities, such as parks and green areas, should be well-connected to residential areas and should be accessible by foot to promote walking and social interactions among residents.

The research also showed that residents who are satisfied with the social cohesion in their neighbourhood and who are attached to their neighbourhood, use public space more frequently, are less lonely and are more satisfied with their life. To promote life satisfaction and to reduce loneliness in neighbourhoods, policy makers should strive to develop public spaces that increase social cohesion and neighbourhood attachment. As was shown by van den Berg et al. (2017), the number of social

interactions is higher in socially cohesive and walkable neighbourhoods. Social interactions in public space should thus be promoted to increase life satisfaction and reduce loneliness.

In 's-Hertogenbosch, policy makers should focus on the development of walking and bicycling paths that connect the inner city to green areas at the outskirts of the city. In the inner city, car-free environments should be expanded, to further support walking and bicycling in these areas. The paths as well as the car-free environments enable all residents of a city to visit public space, to walk outdoors and to meet neighbours, thereby promoting the walkability of the city. Especially in ageing neighbourhoods, such as Maaspoort and Rosmalen Zuid, the accessibility of public spaces by foot is of uttermost importance.

7.3. Discussion and limitations

In this research significant relationships between personal characteristics and use of public space, loneliness and life satisfaction were found. It has, however, also been shown that the sample differs substantially from the population in the Netherlands and in 's-Hertogenbosch. More females, higher educated residents and residents with a higher income responded to the questionnaire. Moreover, limited variation in ethnic background was found and the variable was therefore excluded from analyses. Participants of the survey, especially those who reacted via social media, may also be more active, both physically and psychologically, than residents who did not respond to the questionnaire. Results of the study should, therefore, be carefully interpreted.

The results of the study showed that the neighbourhoods in which residents live, significantly affected the extent to which people use public space. The differences between the three neighbourhoods are thus influential. Since the three neighbourhoods are examples of typical Dutch neighbourhoods, the outcomes of the current study should only carefully be generalized to other cities of the Netherlands. Another limitation of the current research is the relatively small sample. Only 200 of the 297 responses could be used in analyses. As was previously explained, the relatively high RMSEA of the path analysis is a result of the high number of paths relative to a small number of participants to the survey.

Only one of the five components of public space use was found to affect loneliness and one component was found to affect life satisfaction. In this study, public space use was measured by three questions that solely asked about the frequency of activities and visits to places. In previous studies, the distance to public space and the perceived quality of space were also included as measures of public space use. The effects of public space use on loneliness and life satisfaction may have been larger when these characteristics of public space were included.

7.4. Implications for future research

Future research should try to overcome the limitations of the current study. This means that researchers should include a sample that is more mixed in income, educational background and ethnic background. Researchers should also try to retrieve a larger sample to observe whether current findings exist for a larger variety of people. Focusing on disadvantaged neighbourhoods, on neighbourhoods with a large percentage of elderly or on highly urbanized neighbourhoods may also be of interest to observe whether the effect of personal characteristics on both public space use and loneliness and life satisfaction is stronger. It would also be interesting to study the relationships for people living in different regions and countries, to observe whether cultural differences occur.

More extensive characteristics of public space use can also be included in future research. Previous studies focused, for instance, on the distance to public space and the quality of space. These characteristics of public space use could be studied in future research, to observe whether people would be more satisfied with their life and would be less lonely when distances to public space would be smaller or when the quality of space would be higher.

Finally, for future research it is recommended to use a questionnaire that is shorter, that starts with the question in which neighbourhood a respondent lives, that does not include open questions and that has less focus on drawing routes and places in public space. Drawing routes and places on a map was found to be an extensive, long-term activity and should therefore be reduced as much as possible without losing valuable information. Instead of asking participants to draw places and routes that they often and never visit by foot or by bicycle, researchers can consider asking only one of the two questions. Other methods to collect route and public space data can also be considered, such as GPS systems or sensor data. Moreover, the overall extensiveness of the questionnaire caused many respondents to quit and therefore they did not indicate the neighbourhood in which they live. Future research should thus ask about the residential neighbourhood earlier in the questionnaire. Open questions should only be included when the question is easy to be answered.

To conclude, although more research is needed to complement the model, this study showed that both personal and neighbourhood characteristics influence the use of public space, loneliness and life satisfaction. It was also shown that public space use has a limited effect on loneliness and life satisfaction, and, that loneliness affects life satisfaction.

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Appendix A: Article

Loneliness and Life Satisfaction Explained by Public-Space Use and Mobility Patterns

Lisanne Bergefurt [1,*], Astrid Kemperman [1], Pauline van den Berg [1], Aloys Borgers [1], Peter van der Waerden [1], Gert Oosterhuis [2] and Marco Hommel [2]

[1] Department of the Built Environment, Eindhoven University of Technology, 5600MB Eindhoven, The Netherlands; a.d.a.m.kemperman@tue.nl (A.K.); p.e.w.v.d.berg@tue.nl (P.v.d.B.); a.w.j.borgers@tue.nl (A.B.); p.j.h.j.v.d.waerden@tue.nl (P.v.d.W.)

[2] Adviesbureau PLANTERRA, 3833GL Leusden, The Netherlands; gert.oosterhuis@planterra.nl (G.O.); marco.hommel@planterra.nl (M.H.)

* Correspondence: lisanne.bergefurt@gmail.com

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Abstract: Previous research has shown that personal, neighborhood, and mobility characteristics could influence life satisfaction and loneliness of people and that exposure to public spaces, such as green spaces, may also affect the extent to which people feel lonely or satisfied with life. However, previous studies mainly focused on one of these effects, resulting in a lack of knowledge about the simultaneous effects of these characteristics on loneliness and life satisfaction. This study therefore aims to gain insights into how public-space use mediates the relations between personal, neighborhood, and mobility characteristics on the one hand and loneliness and life satisfaction on the other hand. Relationships were analyzed using a path analysis approach, based on a sample of 200 residents of three neighborhoods of the Dutch city 's-Hertogenbosch. The results showed that the influence of frequency of public-space use on life satisfaction and loneliness is limited. The effects of personal, neighborhood, and mobility characteristics on frequency of use of public space and on loneliness and life satisfaction were found to be significant. Age and activities of daily living (ADL) are significantly related to each other, and ADL was found to influence recreational and passive space use and loneliness and life satisfaction. Policymakers should, therefore, mainly focus on creating neighborhoods that are highly walkable and accessible, where green spaces and public-transport facilities are present, to promote physical activity among all residents.

Keywords: public space; neighborhood; loneliness; life satisfaction; mobility; elderly; path analysis

1. Introduction

The belief that exposure to nature, such as trees and water, promotes well-being and life satisfaction, dates as far back as the rise of the first cities. The ancient residents of Rome wrote, for instance, that they valued the contact with nature to escape from the noise and the congestion of the city [1]. In the urbanizing society in which we live nowadays, there is a growing need for nature and public open spaces to escape from our hectic city lives [2]. Within thirty years from now, almost 70% of the world's population is expected to live in urban areas, increasing the demand of high-quality public spaces [3]. In recent years, however, public spaces seem to have diminished or reduced in quality, specifically in highly urbanized areas [4].

The increase in population density in urban areas results in the poorer health and well-being of its residents [5]. People who live in green environments, generally, are more positive about their self-perceived health [4] and about their life satisfaction. Furthermore, people who live in green environments feel less lonely than people who live further away from green spaces [6]. The effect of green spaces on life satisfaction and loneliness is even stronger for people who are assumed to spend

more time at their homes, such as elderly, children, and people with a low economic status [4]. Here, life satisfaction can be defined as a person's cognitive overall assessment of his or her life [7]. Subsequently, loneliness is defined as the discrepancy between an individual's achieved and desired level of social relationships [8].

Public spaces, such as parks, squares, streets, play areas, and civic spaces, can promote social interactions [9]. Social interactions and community involvement are related to life satisfaction. Residents who invest time in their community tend to be happier and to report their life satisfaction to be higher [10]. For elderly people, specifically, having opportunities for social contact in public spaces positively affects life satisfaction [11]. For ageing in places to work well, neighborhoods should facilitate amenities, such as recreational and sports facilities and green spaces, where social interactions between neighbors are promoted [12–15].

With an expected increase in the number of elderly people, from 0.9 million people above 65 in 2018 to 1.8 million in 2060 in the Netherlands [16], renewed interest in the effect of quality of public spaces on people's life satisfaction and loneliness arises [17]. Both the increase in the number of elderly and the urbanization in future decades ask for a strategy that promotes life satisfaction and decreases loneliness of citizens. Since ageing residents have a smaller action radius [13], it is imperative to understand which characteristics of public space can explain the use of space, increase life satisfaction, and reduce loneliness. This requires an analysis in which personal, mobility, and social neighborhood characteristics are used simultaneously to understand loneliness and life satisfaction of residents. This study therefore aims to gain insights into which personal, mobility, and social neighborhood characteristics influence the use of public space, loneliness, and life satisfaction of residents.

2. Literature Review

In recent years, people have started to live more isolated from others, live to an older age, have fewer children, divorce more often, and live further away from friends and family for education and careers. These developments all contribute to people feeling socially excluded and, consequently, lonely [18]. There is growing recognition that not only personal characteristics, such as being older or being healthy, but also neighborhood characteristics, affect the loneliness of people. The subjective feelings about a neighborhood can also be a significant source of life satisfaction [19,20] and loneliness [21].

In addition to the personal and social neighborhood characteristics, mobility characteristics, such as transport-mode use, frequency of visits, and distance from public spaces, were found to affect loneliness [22] and life satisfaction [6,23]. For elderly people, in particular, being able to walk and cycle in public spaces, to meet family and friends outdoors [24], and to have social interactions reduces the risk of becoming lonely [21]. This section continues to discuss the personal and social neighborhood characteristics and the mobility patterns that were found to influence public-space use, life satisfaction, and loneliness.

2.1. Personal Characteristics

Personal characteristics such as age, gender, ethnic background, income, educational background, and household composition are often considered to affect the life satisfaction and loneliness of people. Age was found to be related to life satisfaction, mediated by the effect of health. People who are less healthy reported lower life satisfaction than healthy people [25]. Ageing people, specifically, are more likely to report lower health and are therefore also more likely to be unsatisfied with life [26]. The relationship with loneliness also indicates that the elderly are the most lonely and that loneliness increases over time [27]. The differences in life satisfaction between males and females is found by some authors, who argue that women are generally more satisfied with life than men [28,29]. Women are also found to feel

lonelier than man, especially after the age of 55. Previous research has shown that the increase in loneliness over time is triggered by different life events and experiences, such as losing a partner [30]. It was, moreover, found that differences in life satisfaction exist between people with different ethnic backgrounds, and among males as well as females [29].

Next, the educational background and income of residents are often discussed as factors that influence life satisfaction and loneliness. Among the youngest generations, investing in education is seen as a method to generate wealth and become happier [31]. For the elderly, the relationship between education and satisfaction was not found. Elderly people tend to have lower educational backgrounds but tend to be more satisfied with their life [32]. Some authors therefore argue that income is a stronger contributor to life satisfaction than education. Generally, higher income leads to higher life satisfaction [23,33]. Having a higher income enables people to use paid services, resulting in improved life conditions and human well-being and higher life satisfaction [34]. People who can afford paid services have more opportunities of social interaction and participation and are at lower risk of becoming lonely [35,36].

Having a higher level of education or a larger income reduces the risk of becoming lonely. Other protective factors, such as having a larger household size, being married, and being in good health, limits the vulnerability of people to feeling lonely [30]. For elderly people in particular, the household composition is a strong predictor of loneliness. Being married or living in larger households, instead of living alone, protects them from feeling lonely [30]. Elderly people who live with a partner are more satisfied with life than people who live alone [37]. People who live alone are more likely to be dependent on others, particularly when they are in poor health [38]. Among the oldest residents of a neighborhood, being able to do daily activities independently, such as bathing, dressing, and eating, contributes to life satisfaction [37].

2.2. Mobility

Mobility characteristics consist of the travel behavior and activeness of people. People who make more daily out-of-home trips are, in general, more satisfied with their life [10]. People who travel to places with active modes of transport or with the car are more satisfied with their daily travels than people who use public transport [39]. Residents who make daily trips with different transport modes are also observed to be more satisfied with their life [10]. Having access to different transport modes, such as public transport and a car, increases the opportunities to participate and to interact with others. People who own a car or who use a car are also found to be less lonely than people with limited access to mobility [21].

Another characteristic of mobility, which extends beyond the type of mobility or means of travel and does also include a type of sociability between neighbors, is walkability [40]. People who live in walkable neighborhoods participate more often in events, know their neighbors, and are socially engaged. The extent to which these people perceive themselves as community members mediates the effect between walkability and life satisfaction [41]. Residents of walkable, green neighborhoods have more social interactions [42] and are less prone to becoming lonely than people who live in less-green environments [22].

2.3. Social Neighborhood Characteristics

Social neighborhood indicators are, amongst others, neighborhood attachment and social cohesion. For the ageing population, frequent contact with neighbors contributes to their social network [43]. Elderly people who participate in social activities in a neighborhood are more satisfied with their life than elderly people who participate in less-social activities [44]. Feeling attached to the neighborhood invites people to actively participate in the public space and to have social interactions. People who are

attached to the neighborhood are more satisfied with their life [6] and feel less lonely than people who do not feel attached [45].

The contacts and emotional connections between neighbors, measured as social cohesion, contribute to life satisfaction [46]. Especially among vulnerable groups of people, social cohesion in a neighborhood is a significant indicator of life satisfaction [47]. People who live in neighborhoods with high levels of social cohesion report higher numbers of social interactions [45]. Public spaces where people can meet and get acquainted with the neighborhood stimulate social cohesion [48]. A lack of recreational facilities, sports facilities, and green spaces may result in less social interactions [13], resulting in weaker reported social cohesion [49] and a greater risk of vulnerable residents becoming lonely [50]. For elderly people, being able to access facilities and services enables them to stay independent [51].

3. Materials and Methods

After the literature review, the following relationships are expected. It is assumed that personal characteristics, mobility characteristics, and social neighborhood characteristics influence the use of public space, life satisfaction, and loneliness. In addition, the use of public spaces is expected to affect loneliness and life satisfaction. Finally, it is hypothesized that loneliness affects life satisfaction, meaning that people who feel lonely are less likely to report happiness or satisfaction. Figure 1 shows the expected relationships in a conceptual model.

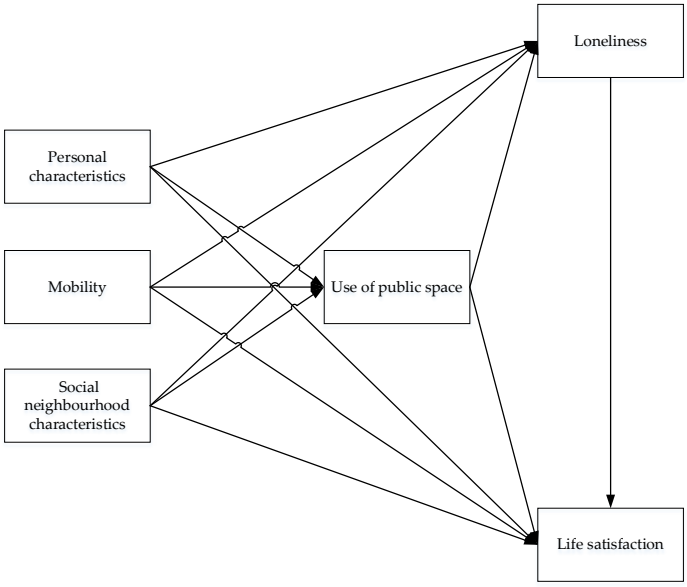

Figure 1. Conceptual model.

3.1. Measurement

3.1.1. Personal Characteristics

Participants were asked about their age, gender, income, educational background, household composition, and activities of daily living. Three categories were used to measure age: 18 to 35 years, 36 to 55 years, and 56 years or older. Income was measured with the categories low (lower than €1200 net per month), middle (between €1200 and €2400 net per month), and high income (higher than €2400 net per month), based on the net modal income of €2120 in the Netherlands. Educational background was broken into three categories, namely low, middle, and high education. Respondents with low education did not finish any education or finished primary or secondary school. Participants with middle education finished an intermediate vocational education. High educated participants finished a higher

vocational or professional education. Household composition was measured by the categories single-person households, couples with children, and couples without children. The ethnic background of participants is not included as a variable, since the variation of ethnicity in the sample was extremely low.

Finally, activities of daily living (ADL) were measured using the Groningen Activity Restriction Scale (GARS), which consists of eighteen activities that show the ability or inability of people to perform activities of daily living [52]. The sum score of the eighteen activities can be used as a measure of ADL and can range from 18 to 72, since Cronbach's Alpha (α) equals 0.955. A score of 18 indicates respondents who are not disabled and 72 represents people who are severely disabled.

3.1.2. Mobility

Mobility characteristics that were included in the questionnaire were transport mode and walkability. The frequency of use of transport modes was operationalized by asking participants to indicate how often they use each of the transport modes on a seven-point scale, ranging from never to (almost) daily [15]. The categories walking and cycling are not included as transport modes, since these transport modes were included in the variables of public-space use. Next, walkability was included, measured by the Neighborhood Environment Walkability Scale, of which four items with the highest factor loadings were selected [53]. These items are: 'Stores are within easy walking distance at my home', 'There are many alternative routes for getting from place to place in my neighborhood', 'The sidewalks in my neighborhood are well maintained', and 'There are many attractive natural sights in my neighborhood'. A sum score was calculated, which ranges from 4 to 20 (α = 0.687), where 4 indicates neighborhoods that are not perceived to be walkable and 20 indicates highly walkable neighborhoods.

3.1.3. Social Neighborhood Characteristics

Two social neighborhood characteristics were addressed in the questionnaire; neighborhood attachment and social cohesion. Neighborhood attachment was measured by the six-item neighborhood attachment scale of Bonaiuto [54]. This scale consists of four aspects describing the bonds toward the neighborhood and people in the neighborhood. The other items are related to the participant's desire to change or not to change their neighborhood. Some items are reverse-scoring items and should therefore be recoded. After recoding, the six items are summed (α = 0.848) and scores range from 6 to 30, where 6 indicates participants who are not attached and 30 indicates people who are very attached to their neighborhood.

The second subjective neighborhood characteristic that was included in the questionnaire was social cohesion. Social cohesion was measured by the social cohesion index of Frieling [55]. The index consists of seven items that are related to cooperation in the development of welfare, solidarity, and feelings of involvement. The seven items are again summed (α = 0.742), with a score ranging from 7 to 35. A score of 7 indicates neighborhoods that are not socially cohesive, and 35 indicates neighborhoods that were reported to have high social cohesion.

3.1.4. Use of Public Space

Use of public space is measured by three questions in the questionnaire, to determine the patterns of outdoor-space use. First, participants were asked to indicate how frequently they walk in the neighborhood for different purposes. Second, respondents had to indicate how frequently they use specific public spaces. Third, participants were asked to answer how often they do specific activities in public space [56]. Each of these activities was measured on a seven-point scale, ranging from never to (almost) daily. The categorization of specific public spaces—parks, sport fields, community garden, day

recreational area, agricultural area, and forest—is based on the categorization of land use in the Netherlands, which is composed by Centraal Bureau voor de Statistiek (CBS), Statistics Netherlands [57]. A principal component analysis (PCA) was performed to aggregate the activities to six components. The six components that arose after PCA were 'recreational use', 'purposeful use and cycling', 'gardening', 'active use', 'passive use', and 'visit green space'. In the Appendix A, the components are described.

3.1.5. Loneliness

Participants of the questionnaire were asked to indicate how often they feel lonely in their neighborhood. For this question, a three-item loneliness scale was used, which consists of three items and three answer possibilities; 'hardly ever', 'some of the time', and 'often'. The three items were 'How often do you feel that you lack companionship?', 'How often do you feel left out?' and 'How often do you feel isolated from others?' [58]. Again, the sum of the three items was calculated ($\alpha = 0.843$), and values ranged from 3 to 9, where 3 indicated respondents who do not feel lonely and 9 indicated people who often feel lonely.

3.1.6. Life Satisfaction

Finally, people were asked to indicate how satisfied they were with their life. The Satisfaction with Life Scale was used to measure this variable [59]. The scale consists of five statements that can be answered by five answer categories, ranging from completely disagree to completely agree. A sum score was calculated that ranged from 5 to 25 ($\alpha = 0.864$). Here, 5 indicated participants of the questionnaire who are not satisfied with their life, and 25 indicated people who are very satisfied with their life.

3.2. Data Collection

To study the relationships that were shown in Figure 1, data were collected using a cross-sectional approach, which consisted of an online questionnaire, including questions about demographics, frequency of use of public spaces, the perception of neighborhood characteristics, and mobility patterns. The questionnaire was approved by an ethics committee, and respondents agreed to give informed written consent to participate in the survey. Data were collected in June and July 2019, among the residents of the three selected neighborhoods in the middle-sized Dutch city 's-Hertogenbosch. The link to the web-based questionnaire of the research was distributed via social media. Meetings with community centers and elderly centers were conducted to increase the response of the elderly target group in the three neighborhoods of 's-Hertogenbosch. After two months, 297 residents responded to the questionnaire, of which 200 responses could be used in further analyses. Ninety-seven cases were deleted, since these participants did not indicate they lived in any of the three neighborhoods. Fifty-three percent of the participants indicated they lived in Maaspoort, 21% in the Binnenstad (inner city), and 26% in Rosmalen Zuid.

The city 's-Hertogenbosch has a population of almost 155,000 (January 2019), compared to a population of nearly 863,000 in Amsterdam (January 2019), which is the biggest city and the capital of the Netherlands. The highway A2 connects the cities Amsterdam, Utrecht, 's-Hertogenbosch, and Eindhoven. The left image of Figure 2 indicates the locations of 's-Hertogenbosch, Utrecht, Amsterdam, and Eindhoven. The zoomed image shows 's-Hertogenbosch, with the three selected neighborhoods for data collection: Maaspoort, Binnenstad (inner city), and Rosmalen Zuid. These neighborhoods were selected for their differences in population and physical characteristics. As is shown in Table 1, the inner city is characterized by a high percentage of facilities and services, which are situated around the main, medieval square of the city. Binnenstad is also located within walking distance from the central train and bus station and is well connected to surrounding neighborhoods. In Maaspoort, the number of facilities, such as shops and restaurants, is lower, but the amount of land that is covered with parks and

recreational areas is relatively high. Rosmalen Zuid is characterized by the highest percentage of elderly people but a lower number of facilities. Rosmalen Zuid has its own train station and is therefore well connected by train.

Table 1. Neighborhood characteristics.

	Maaspoort	Binnenstad	Rosmalen Zuid
Demographics			
Population size	16,734	12,840	9329
Age above 56 (%)	31.9	29.7	40.1
Retail			
Distance to big supermarket (km)	0.7	0.4	1.3
Nr. within 1 km	1.3	3.2	0.8
Restaurants			
Distance to restaurant (km)	0.7	0.9	0.2
Nr. within 1 km	1.2	96.8	1.9
Transport			
Distance to train station (km)	4.3	1.1	1.8
Parks and green areas			
Total area (ha)	565	236	1043
Recreational and parks (%)	22.3	1.6	6.9
Maintenance			
Average rate (1–10)	7.3	7.4	7.1

Figure 2. Three selected neighborhoods in 's-Hertogenbosch, the Netherlands.

3.3. Analytical Approach

The analytical approach that was chosen to analyze the effects of personal characteristics, mobility, and social neighborhood characteristics on public-space use, loneliness, and life satisfaction, was path analysis. The advantage of using a path analysis over bivariate or regression analysis is that multiple, both direct and indirect, relationships between independent and dependent variables can be tested simultaneously. Path analysis is a special case of structural equation modelling, in which only observed variables are used [60]. The path model was estimated using the statistical package LISREL version 8.54.

Before building the path model in LISREL, bivariate analyses between the independent and dependent variables, as indicated in the conceptual model (see Figure 1), were performed to test the significance of hypothesized relationships. All significant relationships of the bivariate analyses were added to the path model. To reduce the number of variables in the path analysis and to overcome the risk of overfitting the model, the relationships that were not found to be significant at the 0.1 ($t \geq 1.65$) significance level in the path model were removed. The backward stepwise process was repeated until an acceptable model fit was found and all insignificant relationships were removed from the model.

4. Results

4.1. Sample Description and Personal Characteristics

Table 2 describes the personal characteristics of the sample. The sample is compared to nationwide averages, measured by CBS [61] and to city-specific data of 's-Hertogenbosch, collected by the municipality of the city [62]. The table shows that the sample is not entirely representative of the population of 's-Hertogenbosch or the Netherlands. The oldest age group in the research is purposefully overrepresented, whereas the middle-aged participants are underrepresented. The sample also contains many female participants and residents with a high educational background. Finally, it can be observed that people who live in households without children are somewhat overrepresented.

In addition to nominal variables, Table 2 also presents the mean and standard deviations of activities of daily living. The mean of the activities of daily living of participants of the research equals 21.88, which indicates that the independence of the sample is high.

Table 2. Characteristics of participants (N = 200).

	Sample (%)	's-Hertogenbosch (%)	Netherlands (%)
Age			
18–35 years	25.5	25.5	24.3
36–55 years	27.5	35.3	33.8
56 years or older	47	39.2	41.9
Gender			
Male	27.5	49	49.7
Female	72.5	51	50.3
Education			
Low	20.5	28	31.1
Moderate	24.5	37.5	37.8
High	55	34.5	31.1
Income			
Low	22.5		
Moderate	41.5		
High	29.5		
Don't know	6.5		
Household composition			
One-person household	28	38.2	39.7
Household without children	36	28.8	28.7
Household with children	36	33	31.6
	Mean	St. deviation	
Activities of daily living (19–72)	21.88	8.915	

Table 3 shows the mean values and standard deviations of the mobility characteristics, neighborhood characteristics, use of public space, loneliness, and life satisfaction. As is shown in the table, participants use the car (as a passenger or as a driver) more often than public transport (trains and buses). For the perception of walkability, a mean value was found that indicates that walkability in the three neighborhoods of 's-Hertogenbosch is perceived to be average. The mean value of neighborhood

attachment equals 18.873, which indicates that most participants feel somewhat attached to their neighborhood. For social cohesion, a mean of 22.289 was found, showing that participants reported social cohesion to be average. In general, participants do not feel lonely and are quite satisfied with their life.

Table 3. Social neighborhood characteristics, mobility, loneliness, and life satisfaction (N = 200).

	Mean	St. Deviation
Car use as a passenger (1–7)	4.32	1.89
Car use as a driver (1–7)	5.29	2.07
Bus use (1–7)	2.15	1.53
Train use (1–7)	2.41	1.62
Perception of walkability (4–20)	15.04	3.19
Neighborhood attachment (7–30)	18.87	4.85
Social cohesion (7–32)	22.29	5.06
Frequency of walking/ cycling (8–56)	27.90	8.31
Frequency of use of specific spaces (7–49)	14.59	6.60
Frequency of specific activities (8–56)	22.65	6.35
Loneliness (3–9)	3.82	1.36
Life satisfaction (5–25)	18.29	4.04

4.2. Path Analysis

Table 4 shows the goodness of fit of the model. Chi-Square divided by the degrees of freedom should ideally be smaller than 2, but smaller than 5 is acceptable [63]. In the current research, Chi-Square is 2.5 times larger than the degrees of freedom. The root mean square error of approximation (RMESA) should, additionally, be below 0.05, in order to indicate a good fit of the model to the data [64]. The RMSEA of the current model equals 0.089, which indicates a modest fit. The Goodness of Fit Index equals 0.91 and should preferably be greater than 0.90 to indicate a good model [64].

Table 4. Goodness-of-fit of the model.

Degrees of Freedom	100
Full Information ML Chi-Square	254.02
RMSEA (Root Mean Square Error of Approximation)	0.089
90 Percent Confidence Interval for RMSEA	0.075; 0.10
P-value for Test of Close Fit (RMSEA < 0.05)	0.0000
Goodness of Fit Index	0.91

4.3. Relationships Path Model

With the results of the path model, the expected relationships between the dependent variables and the explanatory variables could be tested. Table 5 and Figure 3 indicate the significant relationships in the path model at the 0.1 significance level. In Figure 3, significant positive relationships are drawn with a black arrow and negative relationships with a dashed black arrow. Since no significant relationships are found between any of the explanatory variables and gardening, this component is deleted from further analysis and from the path model.

4.3.1. Recreational Use

Table 5 shows that age, activities of daily living (ADL), neighborhood, and neighborhood attachment significantly affect recreational use. Positive relationships are found between the two oldest age groups and recreational use. This indicates that residents who are older use public spaces for recreational purposes more often. In addition, a significant relationship between ADL and recreational space use is

found. People with a lower ADL use public spaces for recreational activities less often than people with a high ADL. Recreational use of public spaces is also found to be positively affected by the neighborhoods Binnenstad and Maaspoort. Residents of these neighborhoods more frequently use public spaces for recreational purposes than residents of Rosmalen Zuid. Finally, neighborhood attachment affects recreational use. People who are attached to their neighborhood use public spaces for recreational activities more often.

4.3.2. Purposeful Use and Cycling

Purposeful use and cycling are significantly affected by the variables train use, neighborhood, social cohesion, and perception of walkability. People who frequently use the train are also more likely to frequently use public spaces for specific purposes or to cycle. Residents of the neighborhoods Maaspoort and Binnenstad use public spaces for specific purposes or for cycling more often than residents of Rosmalen Zuid. Purposeful use and cycling are also affected by social cohesion, which indicates that people who live in socially cohesive neighborhoods cycle or use public space for specific purposes more often than other residents. Finally, people who observe their neighborhood to be walkable purposefully use public spaces or cycle in their neighborhood more often.

Table 5. Results path model (unstandardized coefficients).

		Life Satisfaction	Loneliness	Recreational Use	Purposeful Use and Cycling	Active Use	Passive Use	Visit Green Space
Variables	*Categories*	*Unstandardized coefficients*						
Age	18–35	-	-	-	-	-	-	-
	36–55			4.31 **				
	56 or above			3.39 **				
Education	Low					−0.63		
	Moderate	-	-	-	-	-	-	-
	High					1.02 *		
Income	Low							0.65
	Moderate	-	-	-	-	-	-	-
	High							1.00 **
	Unknown	-	-	-	-	-	-	
Household composition	Single persons	-	-	-	-	-	-	-
			−0.87 **					0.88 *
	Couple without children		−0.55 **					1.04 **
	Couple with children							
Activities of daily living		−0.07 **	0.03 **	−0.18 **			−0.10 **	
Car use as a driver							−0.48 **	
Train use					0.82 *	0.62 **		
Neighborhood	Maaspoort	-	-	4.68 **	1.75 *	−0.46	−1.16	
	Binnenstad			5.69 **	4.75 **	3.40 **	1.58 *	
	Rosmalen Zuid			-	-	-	-	-
Neighborhood attachment				0.38 **			0.14 **	0.07 *
Social cohesion		0.12 **	−0.04 **		0.27 **		0.18 **	0.08 **
Perception of walkability					0.48 **	0.25 **		0.11 *
Active use		0.10 *						
Passive use			−0.04 *					
Loneliness		−0.93 **						
R-Squared		**0.22**	**0.19**	**0.20**	**0.29**	**0.39**	**0.23**	**0.16**

** $p < 0.05$, * $p < 0.1$.

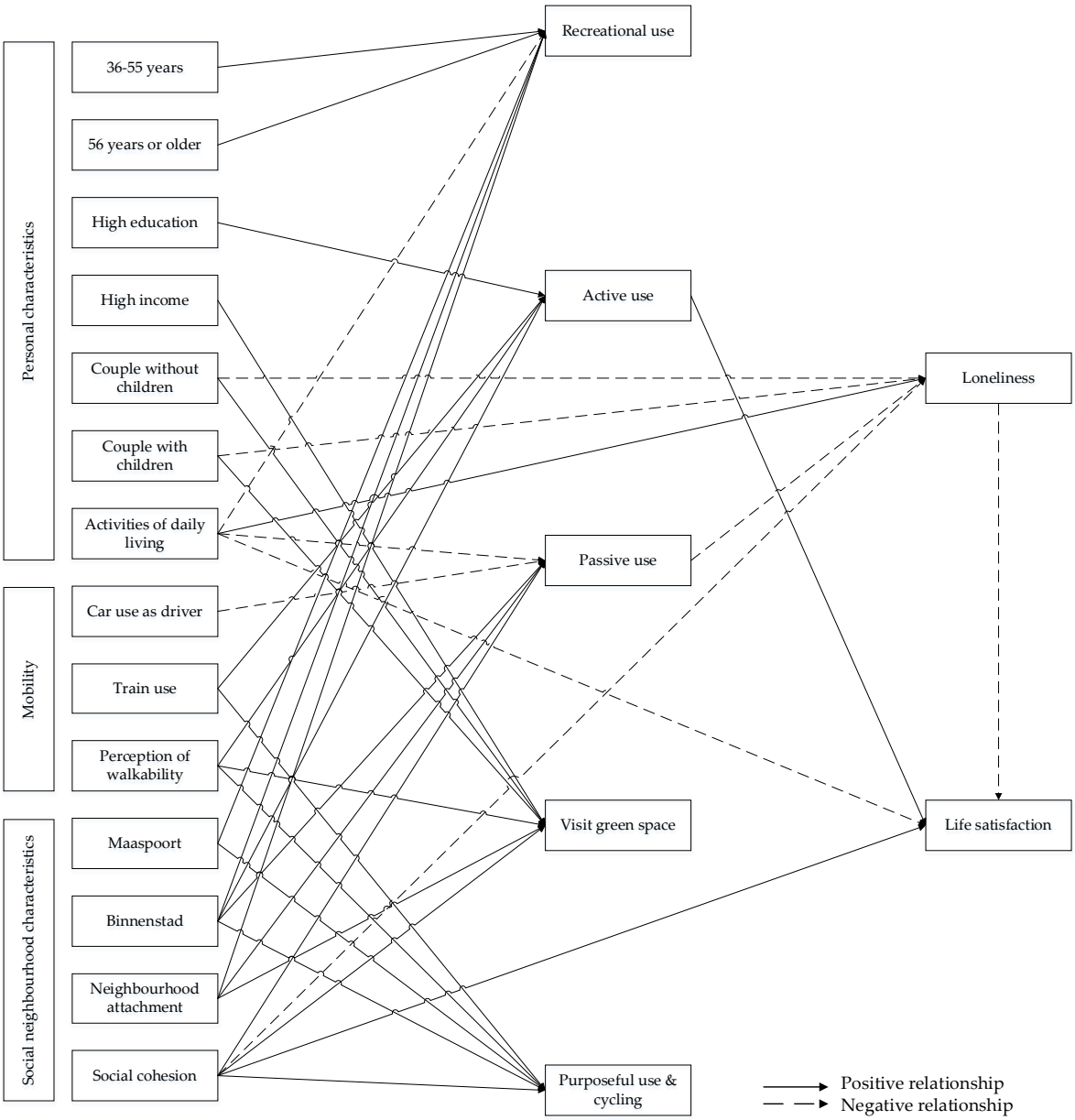

Figure 3. Relationships in path model.

4.3.3. Active Use

For active use, the variables education, train use, neighborhood, and perception of walkability are found to be influential. Residents with a high educational background use public space for active purposes more frequently than other residents. Moreover, frequent train users are more likely to actively use public spaces. Residents of the neighborhood Binnenstad also use public spaces for active purposes more often than residents of Rosmalen Zuid and Maaspoort. Furthermore, the perception of walkability significantly affects active use, indicating that residents who perceive their neighborhood to be walkable use public space for active purposes more often.

4.3.4. Passive Use

Passive use is significantly affected by activities of daily living (ADL), car use as a driver, neighborhood, social cohesion, and neighborhood attachment. ADL is negatively related to passive space use, which indicates that people who are more dependent on others in performing ADL use public spaces for

passive activities less frequently. In addition, people who frequently drive a car are found to use public spaces for passive activities less frequently. Furthermore, residents of the neighborhood Binnenstad more often passively use public spaces than residents of Maaspoort and Rosmalen Zuid. Social cohesion is also found to be associated with passive use, indicating that residents of socially cohesive neighborhoods visit public spaces for passive activities more often than residents of neighborhoods with weaker social cohesion. Finally, residents who are attached to their neighborhood use public spaces for passive activities more often.

4.3.5. Visiting Green Spaces

Income, household composition, neighborhood attachment, social cohesion, and perception of walkability all significantly affect the visiting of green spaces. Residents with a higher income visit green spaces more frequently than people with a low or moderate income. Couples with children and couples without children visit green spaces more often than single-person households. Next, residents who are attached to their neighborhood visit green spaces more frequently than residents who do not feel attached. Social cohesion, in addition, also affects the frequency of visits to green spaces, indicating that residents who live in socially cohesive neighborhoods visit green spaces more often than other residents. Finally, people who perceive their neighborhood to be walkable visit green spaces more often.

4.3.6. Loneliness

Next to the relationships with the five components of public-space use, significant associations with loneliness are found in the path analysis. The variables household composition, activities of daily living (ADL), social cohesion, and passive space use are all observed to significantly affect the loneliness of people. Single persons are found to be lonelier than couples with or without children. Moreover, residents who are dependent on others in performing ADL generally feel lonelier than people who are not dependent on others. Another significant relationship exists between social cohesion and loneliness: People who report social cohesion to be low feel lonely more often than residents of socially cohesive neighborhoods. Finally, passive space use affects loneliness, which indicates that people who frequently use public space for passive activities are less likely to feel lonely. Only one of the five components of public-space use is thus significantly associated with loneliness.

4.3.7. Life Satisfaction

For life satisfaction, significant effects of activities of daily living (ADL), social cohesion, active use, and loneliness are observed. Residents who can perform ADL independently are more likely to be satisfied with their life. Moreover, people who live in socially cohesive neighborhoods are more likely to report high life satisfaction. Next, active use affects life satisfaction, which indicates that residents who frequently visit public spaces for active purposes are more likely to be satisfied with their life. Only one of the five components of public-space use significantly affects life satisfaction. Finally, a significant effect of loneliness on life satisfaction can be observed, which indicates that people who feel lonely are less satisfied with their life.

5. Discussion

The main aim of the current research was to analyze the relationships between personal, mobility, and social neighborhood characteristics and public-space use, loneliness, and life satisfaction. In addition, the effect of public-space use on loneliness and life satisfaction, and the effect of loneliness on life satisfaction, was studied. The results showed a significant relationship between loneliness and life satisfaction, but a limited effect of public-space use on loneliness and life satisfaction was observed. For life satisfaction, a relationship with active use was found. In addition, for loneliness, a relationship with

passive use was found. The effect of passive use on loneliness indicates that the enjoyment of public-space visits is more important than the actual activities that are performed in the public space. Based on data collected using a questionnaire that was distributed via social media and meetings with community and elderly centers, 200 responses were retrieved, and a path model was estimated. As was shown, the RMSEA of the path model equaled 0.089, which is rather high. This may be caused by the large number of paths relative to a small sample (N = 200) [65].

Due to the nonrandom distribution method of the questionnaire, by visiting community and elderly care centers, purposeful overrepresentation of the oldest age group occurred. Differences between the population of 's-Hertogenbosch and the sample were found for gender. In the sample, females were overrepresented, which may be a result of the time that women spend at home relative to the time spend by males. Overrepresentation of people with a high educational background may, in addition, be caused by the willingness of respondents to participate in the study, which is generally higher among highly educated individuals. Finally, the overrepresentation of households without children may be related to the higher percentage of residents aged above 56, who usually have children that moved out of house.

As was shown in the path analysis, residents above the age of 56 visit public spaces for recreational activities more frequently than people aged between 35 and 55. Previous research explained this finding by arguing that middle-aged residents are more often employed full-time and travel outside their neighborhood on a daily basis. They are, therefore, also more likely to use public spaces outside their neighborhood [66]. We did, however, not find a significant effect of age on life satisfaction or loneliness, while other studies did find this effect [38,50]. An ANOVA test ($F = 6.007$, p-value = 0.003) indicated that the dependence on others to perform activities of daily living (GARS score) increases with age (for 18–35 years old M = 19.06, SD = 4.388, for 36–55 years old M = 20.81, SD = 8.55, for 56 years or older M = 24.04, SD = 10.37). Differences in loneliness and life satisfaction between age groups can thus be explained by differences in ADL.

ADL was also found to affect recreational use and passive use. Although these relationships have not been studied before, previous studies did show that people with limited ADL walk significantly less for recreational activities than residents without functional limitations [67]. Residents with a low ADL have lower mobility levels, which further limits the options to visit public spaces [68,69]. These residents are therefore more likely to perceive neighborhood facilities to be poor [68]. Due to physical limitations, residents are probably not able to reach public spaces independently and, therefore, cannot use them in any form.

Other personal characteristics that were found to affect active use or green-space visitation were education and household composition. Previous studies showed that highly educated residents are more likely to use public spaces for family and sporting activities than lower educated people [70]. In general, those with a higher education are more likely to be physically active according to the prevailing recommendations than those who did not complete secondary school [71]. In addition, young families with children, or families who expect to have children, move to family houses that are close to nature, to be able to use public spaces [70,72]. Public spaces can provide opportunities for children to play and for parents and other adults to meet with neighbors. The finding that single persons are lonelier than couples with or without children may also be related to the social interactions in public spaces. More in-depth research is needed on the actual relationships between household composition, income, education, and public-space use and loneliness.

Next to the personal characteristics, the perception of walkability was found to significantly affect active use, purposeful use and cycling, and the visiting of green spaces. Residents who perceived their

neighborhood to be unwalkable were less likely to use public spaces. These findings are confirmed by a previous study in which a lack of walkability emerged as one of the main barriers to use public spaces [56]. In contrast, people who live in highly walkable neighborhoods cycle and walk to public spaces more frequently and can enhance their health [73]. More specifically, users of parks and other green spaces have higher daily walking minutes than people who do not use green spaces [74]. The walkability of neighborhoods encourages residents to go outside [75] and to socially engage in their living environment [41]. Highly walkable, green neighborhoods, moreover, prevent residents from becoming lonely. Policymakers should therefore aim to create neighborhoods that are highly walkable, where people are invited to go outside and meet their neighbors. Walkability can be promoted by a higher residential density, mixed land use, and high street connectivity [75]. In the case of 's-Hertogenbosch, the presence of accessible, natural features, such as parks and green spaces, that are well connected to the residential areas, can promote walkability. These neighborhood features may also contribute to the satisfaction of all residents and may prevent dependent residents from becoming lonely.

The results of the current study also indicate that frequent train users are more likely to use public spaces for specific purposes and cycle more than others in the neighborhood. Moreover, train users frequently use public spaces for active purposes. Both these results indicate that public-transport users are more physically active than people who use other transport modes, such as a car. Previous theory has shown that the mobility characteristics of an individual affect the satisfaction with life [10] and loneliness [21]. People who have access to different transport modes, such as the car and public transport, were found to have more social interactions with others [21]. Moreover, public-transport users meet physical activity recommendations more easily, since they walk significantly more than car users. As was also shown for users of green spaces, public transport users were found to have longer daily walks than people who use the car [74]. Policymakers should therefore focus on creating public-transport facilities that are highly accessible, to promote both public transport and active transport modes within urbanized areas. If public transport facilities are within walking distance, residents may be more likely to use them and to reduce their car use.

Finally, neighborhood attachment and social cohesion have a significant effect on the use of public spaces. Neighborhood attachment was found to affect recreational use, passive use, and the visiting of green spaces. Social cohesion was also found to affect passive use, the visiting of green space, and purposeful use and cycling. Moreover, social cohesion significantly affected loneliness and life satisfaction. To the best of our knowledge, the direct effects of neighborhood attachment and social cohesion on the use of public space have not been studied before. Previous research mainly focused on the indirect relationship between neighborhood attachment or social cohesion and public-space use, through the effect of social interactions in a neighborhood [71,76]. Zhang and Zhang (2017), for instance, argued that people feel more attached to their neighborhood when opportunities to communicate with others exist in public spaces. In these socially cohesive neighborhoods, people are generally less prone to feeling lonely [45]. To reduce loneliness and increase life satisfaction of residents in a neighborhood, social cohesion should be promoted. In socially cohesive neighborhoods, public spaces encourage residents to meet neighbors and to have social interactions, thereby strengthening feelings of attachment and social cohesion. Policymakers should therefore strive to create public spaces that are inviting, where people can meet with neighbors and feel socially involved. Future research could look in more detail at the relationships between social cohesion, public-space use, and life satisfaction and loneliness for urban, as well as rural, neighborhoods.

6. Limitations

One of the limitations of this research is that it was based on a rather small sample of ‘s-Hertogenbosch in the Netherlands. Although elderly participants of the survey were recruited via meetings with community and elderly centers, other participants of the survey could respond via social media. These respondents may therefore be more active, both physically and psychologically, in the neighborhoods than residents who did not participate. Moreover, an overrepresentation of highly educated and high-income participants occurred in the sample. Furthermore, no racial variation existed, and, therefore, ethnic background was deleted from the analysis. In addition, controlling for ADL is important; however, the measurement of ADL is usually used for frail older adults, while this sample contains a relatively large share of younger adults. Results of the study should therefore be carefully interpreted. Relationships between the three selected neighborhoods and public-space use are also significant, which indicates that differences between the neighborhoods are influential. It is, therefore, not possible to generalize the outcomes to other cities of the Netherlands or cities outside the Netherlands.

For future research, it would be interesting to analyze the use of public spaces, loneliness, and life satisfaction of people living in different regions and countries, to find whether cultural differences occur. Future research could also include more extensive characteristics of public space, such as the observed quality and distance to public space, to get a more comprehensive understanding of public-space use on life satisfaction and loneliness. Finally, future research should use a larger sample, including more neighborhoods and other regions, to reduce the RMSEA of the path analysis, to ensure a good model fit to the data, without losing significant paths. Performing the study in other regions and in more neighborhoods of a city also helps to gain more insights into the relationships that were significant in the current study.

7. Conclusions

Hitherto, research that simultaneously analyzes the effects of both personal and social neighborhood characteristics on life satisfaction and loneliness is still limited [19]. Therefore, the main contribution of this study is that the relationships between personal, neighborhood, and mobility characteristics and life satisfaction and loneliness are observed in an empirical study, whereas previous studies mainly focused on only one of these characteristics. This study, moreover, analyzed the frequency with which residents use public spaces and whether public-space use affects loneliness or life satisfaction. A path analysis was used to analyze the significance of these relationships simultaneously. The questionnaire that was used to obtain the data was distributed via social media and community centers, enabling a diverse group of residents of ‘s-Hertogenbosch to participate. As a result, a heterogenous sample of residents of three neighborhoods of ‘s-Hertogenbosch was retrieved.

The results showed that personal, neighborhood, and mobility characteristics influence specific uses of public spaces, loneliness, and life satisfaction. Loneliness is also found to affect life satisfaction, indicating that residents who feel lonely are less likely to be satisfied with their life. The relationships between public-space uses and loneliness and life satisfaction are, however, found to be limited. As was also argued in previous research, the effect of age on public-space use, loneliness, and life satisfaction is small; instead, it was found that the dependence of people in performing activities of daily living is influential. In general, ageing residents are most dependent on others in performing daily activities.

Overall, results of this study are relevant for policymakers who focus on creating cohesive, walkable, and accessible neighborhoods that contribute to the well-being of all its residents. Specifically, walkability and accessibility of public space, supported by public-transport facilities and green spaces, should be promoted to support physical activity and independence of residents of all age groups.

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Appendix A

For the indicators frequency of walking/cycling, frequency of use of specific spaces, and frequency of specific activities (see first column in Table A1 for the complete list of items included), a principal component analysis was performed. PCA with orthogonal rotation (varimax) was conducted to reduce the number of items of these three indicators that explain the use of public space. As is shown in Table A1, PCA results in six components with an eigenvalue above 1, that together account for 58% of the variance.

Component 1 'Recreational use': This component loads on parks, walking, visiting green spaces, visiting them for pleasure, and walking with the dog. All of these items are based on visiting a park or other green space for recreational purposes.

Component 2 'Purposeful use and cycling': This component loads on bicycling, visiting someone or a specific place, and making purchases. The items of the second component consist of visits to specific places and cycling.

Component 3 'Gardening': This component loads on community garden and gardening in a community garden, day recreational area, and agricultural area. The items all specify a type of public space that can be used for specific purposes, such as gardening.

Component 4 'Active use': This component loads on picnicking, running, and visiting a restaurant and other places. The component exists of items that are active of nature, such as visiting places and running.

Component 5 'Passive use': This component loads on outdoor sitting and watching, other activities, waiting at a bus stop, and gathering outdoors. These uses of public space are all quite passive and do not involve high levels of physical activity.

Component 6 'Visit green space': This component loads on sports fields and forests. The two items are examples of types of green spaces that can be used, usually at the outskirts of a city.

Table A1. Principal component analysis of public-space use.

	Public-Space Use					
	Rotated Factor Loadings					
	Recreational Use	Purposeful Use and Cycling	Gardening	Active Use	Passive Use	Green Space
Park	**0.809**	0.066	−0.022	0.207	0.182	0.136
Walking	**0.743**	0.203	0.093	−0.031	−0.054	0.038
To visit green space	**0.732**	0.114	0.152	0.249	0.082	0.001
For pleasure	**0.690**	0.201	0.140	−0.001	0.124	0.069
To walk dog	**0.608**	0.017	0.151	−0.215	−0.287	0.041
Biking	0.074	**0.745**	0.123	0.064	−0.075	0.279
To visit someone	0.237	**0.734**	−0.046	0.007	0.109	0.160
To visit place	0.037	**0.658**	−0.001	0.291	0.190	−0.041
To make purchase	0.380	**0.576**	0.002	0.074	0.098	−0.056
Community garden	0.222	0.079	**0.860**	−0.023	0.111	0.054
Gardening	0.047	0.025	**0.851**	−0.123	−0.026	−0.094
Agricultural area	0.198	−0.117	**0.537**	0.304	−0.065	0.361
Day recreational area	0.108	0.113	**0.393**	0.361	0.162	0.386
Picnicking	0.033	0.100	0.073	**0.768**	0.091	0.011
Running	−0.024	0.051	−0.157	**0.680**	−0.170	0.204
To go to restaurant	0.183	0.306	−0.012	**0.519**	0.427	−0.042
Other places	0.311	0.242	0.110	**0.341**	0.130	0.115
Outdoor sitting and watching	0.395	0.021	0.030	0.143	**0.598**	−0.168
Other activities	−0.188	0.277	0.202	−0.041	**0.582**	0.236
To wait at bus stop	0.126	0.372	0.199	0.324	**−0.488**	−0.298
Outdoor gathering	0.125	0.399	0.023	0.085	**0.481**	0.261
Sport fields	−0.007	0.254	−0.128	0.035	0.067	**0.683**
Forest	0.219	0.027	0.301	0.160	0.083	**0.564**
Eigenvalues	*5.315*	*2.302*	*1.855*	*1.489*	*1.332*	*1.087*
% of variance	*23.110*	*10.007*	*8.066*	*6.473*	*5.790*	*4.726*

The bold formatted numbers in the table indicate the items that load high on the components.

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Appendix B: Survey questions (Dutch)

Deel 1: Persoonlijke kenmerken

Dit is het eerste deel van de enquête, bestaande uit 10 vragen over uw persoonlijke situatie.

Meerdere vragen bevatten een 'overige' categorie, gelieve deze categorie alleen te gebruiken wanneer de andere categorieën uw antwoord niet bevatten.

1. Wat is uw leeftijd?
   - o 18-25 jaar
   - o 26-35 jaar
   - o 36-45 jaar
   - o 46-55 jaar
   - o 56-65 jaar
   - o 66-75 jaar
   - o 76-85 jaar
   - o 86 jaar of ouder

2. Wat is uw geslacht?
   - o Man
   - o Vrouw

3. Wat is de hoogste opleiding die u afgerond heeft met een certificaat of diploma?
   - o Geen
   - o Lagere school (incl. speciaal onderwijs zoals LOM, BLO)
   - o Middelbare school (incl. lbo, vso, huishoudschool, ambachtsschool, vmbo, lwoo, mavo, ulo, mulo, havo, mms, vwo, gymnasium, atheneum, hbs, lyceum)
   - o Mbo (incl. mts, meao, middenstandsdiploma, pdb, mba)
   - o Hbo (incl. hts, heao, kweekschool, associate degree)
   - o WO/Universiteit (incl. postdoctoral degree, PhD)
   - o Overige

4. Wat is uw individuele netto maandelijkse inkomen?
   - o Lager dan €1200 euro per maand
   - o Tussen €1200 en €2400 euro per maand
   - o Hoger dan €2400 per maand

5. Wat is uw afkomst?
   - o Nederlands
   - o Anders, namelijk: [ ]

6. Hoe ziet uw huishoudsamenstelling eruit?
   - o Eenpersoonshuishouden
   - o Samenlevend, geen kinderen
   - o Samenlevend met kinderen
   - o Eenoudergezin
   - o Anders

7. Hoe vaak voelt u…

	1. Zelden	2. Soms	3. Vaak
A. Een gemis aan gezelschap?	o	o	o
B. Zich buitengesloten?	o	o	o
C. Zich geïsoleerd van anderen?	o	o	o

8. Kunt u voor elk van de volgende activiteiten aangeven of u in staat bent om die activiteit zonder hulp uit te voeren?

	1. Ja, volledig onafhankelijk zonder moeite	2. Ja, volledig onafhankelijk met enige moeite	3. Ja, volledig onafhankelijk met veel moeite	4. Nee, niet onafhankelijk, alleen met hulp
A. Uzelf aankleden.	o	o	o	o
B. Uw gezicht en handen wassen.	o	o	o	o
C. Uzelf kunnen voortbewegen binnenshuis.	o	o	o	o
D. Het bereiden van uw ontbijt/lunch.	o	o	o	o
E. Naar het toilet gaan.	o	o	o	o
F. Opstaan uit een stoel.	o	o	o	o
G. Het verrichten van licht schoonmaakwerk.	o	o	o	o
H. Buitenshuis wandelen.	o	o	o	o
I. Uw lichaam drogen/ wassen.	o	o	o	o
J. Het bereiden van uw avondeten.	o	o	o	o
K. De trap op- en afgaan.	o	o	o	o
L. Het wassen en strijken van kleren.	o	o	o	o
M. Uw voeten/ teennagels verzorgen.	o	o	o	o
N. Het opmaken van bedden.	o	o	o	o
O. Boodschappen doen.	o	o	o	o
P. Het verrichten van zwaar schoonmaakwerk.	o	o	o	o
Q. In en uit bed komen.	o	o	o	o
R. Uzelf voeden.	o	o	o	o

9. Hoe vaak gebruikt u de volgende vormen van transport?

	1. Nooit	2. Minder dan eens per maand	3. Eens per maand	4. 2 of 3 keer per maand	5. Een keer per week	6. 2 tot 5 keer per week	7. (Bijna) dagelijks
A. Auto (als bestuurder)	o	o	o	o	o	o	o
B. Auto (als inzittende)	o	o	o	o	o	o	o
C. (Elektrische) fiets	o	o	o	o	o	o	o
D. Wandelen	o	o	o	o	o	o	o
E. Bus	o	o	o	o	o	o	o
F. Trein	o	o	o	o	o	o	o
G. Overige (o.a. taxi, scootmobiel, brommer)	o	o	o	o	o	o	o

10. Kunt u aangeven in welke mate de volgende uitspraken waar zijn in uw situatie?

	1. Volledig oneens	2. Oneens	3. Neutraal	4. Eens	5. Volledig eens
A. In het algemeen is mijn leven (bijna) perfect.	o	o	o	o	o
B. De condities van mijn leven zijn uitstekend.	o	o	o	o	o
C. Ik ben tevreden met mijn leven.	o	o	o	o	o
D. Tot nu toe heb ik alle belangrijke dingen bereikt in mijn leven.	o	o	o	o	o
E. Als ik mijn leven over zou doen, dan zou ik (bijna) niets veranderen.	o	o	o	o	o

Deel 2: Perceptie van de omgeving

In het tweede deel van de enquête volgen een aantal vragen over uw beleving van de wijk. Elk van de vragen bestaat uit beweringen, die u kunt beoordelen op de mate waarin ze aansluiten bij uw beleving van uw woonwijk.

11. Kunt u aangeven in welke mate de volgende uitspraken waar zijn in uw situatie?

	1. Volledig oneens	2. Oneens	3. Neutraal	4. Eens	5. Volledig eens
A. Dit is de ideale wijk om in te wonen.	o	o	o	o	o
B. Deze wijk vormt een deel van mij.	o	o	o	o	o
C. Er zijn plaatsen in de wijk waar ik emotioneel aan gehecht ben.	o	o	o	o	o
D. Ik zou het moeilijk vinden deze wijk te verlaten.	o	o	o	o	o
E. Ik zou deze wijk vrijwillig verlaten.	o	o	o	o	o
F. Ik zou deze wijk niet vrijwillig verlaten.	o	o	o	o	o

12.1 Hoe vaak maakte u in het afgelopen jaar een praatje met iemand uit de buurt?

- o Eens per jaar of minder vaak
- o Een aantal keren per jaar
- o Een aantal keren per maand
- o Eens per week
- o Een aantal keren per week of vaker

12.2 Als u wat langer weg bent van huis, is er dan iemand in uw buurt die een oogje in het zeil houdt?

- o (Bijna) nooit
- o Meestal niet
- o Soms wel/ niet
- o Meestal wel
- o (Bijna) altijd
- o Niet van toepassing

12.3 Als er iets belangrijks gebeurt in de buurt of met een buurtgenoot, is er dan iemand uit uw buurt die u hiervan op de hoogte brengt?

- o (Bijna) nooit
- o Meestal niet
- o Soms wel/ niet
- o Meestal wel
- o (Bijna) altijd
- o Niet van toepassing

12.4 Als er een droevig moment of een droevige gebeurtenis is in uw leven, is er dan iemand uit uw buurt die voor u een steun en toeverlaat is?

- o (Bijna) nooit
- o Meestal niet
- o Soms wel/ niet
- o Meestal wel
- o (Bijna) altijd
- o Niet van toepassing

12.5 Zijn er in de buurt weleens buurtfeesten of buurtbarbecues waarvoor de hele buurt is uitgenodigd?

- o (Bijna) nooit
- o Meestal niet
- o Soms wel/ niet
- o Meestal wel
- o (Bijna) altijd
- o Niet van toepassing

12.6 Voelt u zich betrokken bij mensen die in uw directe buurt wonen?

- o Bij bijna niemand
- o Bij de meeste mensen niet
- o Bij sommige wel/ niet
- o Bij de meeste mensen wel
- o Bij bijna iedereen

12.7 Heeft u in het afgelopen jaar samengewerkt met andere buurtbewoners om iets te organiseren voor de buurt, bijvoorbeeld een buurtfeest of activiteit?

- o Niet samengewerkt
- o Ongeveer eens in het half jaar of minder vaak samengewerkt
- o Ongeveer eens in de drie maanden samengewerkt
- o Ongeveer eens in de twee maanden samengewerkt
- o Ongeveer maandelijks of vaker samengewerkt

13. Kunt u aangeven in welke mate de volgende uitspraken waar zijn in uw situatie?

	1. Volledig oneens	2. Oneens	3. Neutraal	4. Eens	5. Volledig eens
A. Winkels zijn binnen wandel-/fietsafstand van mijn huis.	o	o	o	o	o
B. Er zijn veel alternatieve routes om van plaats naar plaats te gaan in mijn wijk.	o	o	o	o	o
C. De trottoirs in mijn wijk zijn goed onderhouden.	o	o	o	o	o
D. Er zijn veel aantrekkelijke (natuurlijke) bezienswaardigheden in mijn wijk.	o	o	o	o	o
E. Er is zoveel verkeer op nabijgelegen wegen dat het moeilijk of onprettig is om in mijn wijk te wandelen of fietsen.	o	o	o	o	o
F. De mate van criminaliteit in mijn wijk maakt het onveilig om 's avonds door de wijk te wandelen.	o	o	o	o	o

Deel 3: Het gebruik van de openbare ruimte

Het derde deel van de enquête betreft vragen over uw gebruik van de openbare ruimte. Een deel van deze vragen kunt u beantwoorden door één van de antwoordcategorieën te kiezen. Een ander deel van de vragen bestaat uit open vragen. Hier wordt u gevraagd om uw mening aan te geven. Tenslotte wordt u in de markeringsvragen gevraagd om uw meest en minst gebruikte openbare ruimtes en routes te markeren.

14. Hoe vaak wandelt of fietst u in uw wijk?

	1. Nooit	2. Minder dan eens per maand	3. Eens per maand	4. 2 of 3 keer per maand	5. Een keer per week	6. 2 tot 5 keer per week	7. (Bijna) dagelijks	8. Niet van toepassing
A. Voor uw plezier.	o	o	o	o	o	o	o	o
B. Om iemand te bezoeken.	o	o	o	o	o	o	o	o
C. Om een park/ groene omgeving te bezoeken.	o	o	o	o	o	o	o	o
D. Om de hond uit te laten (als u een hond heeft).	o	o	o	o	o	o	o	o
E. Om een boodschap te doen.	o	o	o	o	o	o	o	o
F. Om naar een bushalte te gaan.	o	o	o	o	o	o	o	o
G. Om naar een restaurant/ café te gaan.	o	o	o	o	o	o	o	o
H. Om een specifieke plek te bezoeken (bijv. werk, kerk, school).	o	o	o	o	o	o	o	o

15. Hoe vaak bezoekt of gebruikt u de volgende openbare ruimtes in uw wijk?

	1. Nooit	2. Minder dan eens per maand	3. Eens per maand	4. 2 of 3 keer per maand	5. Een keer per week	6. 2 tot 5 keer per week	7. (Bijna) dagelijks	8. Niet van toepassing
A. Park	o	o	o	o	o	o	o	o
B. Sportvelden	o	o	o	o	o	o	o	o
C. Gemeenschappelijke tuin	o	o	o	o	o	o	o	o
D. Dag recreatief gebied	o	o	o	o	o	o	o	o
E. Agrarisch gebied	o	o	o	o	o	o	o	o
F. Bos	o	o	o	o	o	o	o	o
G. Andere plekken in de openbare ruimte	o	o	o	o	o	o	o	o

Dag recreatief gebied: bijvoorbeeld een dierentuin, openluchtmuseum of pretpark
Agrarisch gebied: bijvoorbeeld grasland, tuinland, bouwland of een boomgaard

16. Hoe vaak doet u de volgende activiteiten in uw wijk?

	1. Nooit	2. Minder dan eens per maand	3. Eens per maand	4. 2 of 3 keer per maand	5. Een keer per week	6. 2 tot 5 keer per week	7. (Bijna) dagelijks	8. Niet van toepassing
A. Buiten zitten en rondkijken	o	o	o	o	o	o	o	o
B. Hardlopen	o	o	o	o	o	o	o	o
C. Fietsen	o	o	o	o	o	o	o	o
D. Buitenshuis vrienden ontmoeten	o	o	o	o	o	o	o	o
E. Picknicken	o	o	o	o	o	o	o	o
F. Wandelen	o	o	o	o	o	o	o	o
G. Tuinieren in een gemeenschappelijke tuin	o	o	o	o	o	o	o	o
H. Andere activiteiten	o	o	o	o	o	o	o	o

17. Kunt u uw thuislocatie aangeven op de kaart met behulp van een stip? (Maaspoort, Binnenstad, Rosmalen Zuid)

18. Kunt u op de kaart aangeven welke openbare ruimte u, gemiddeld, vaker dan eens per maand bezoekt?
    A. Park
    B. Sportvelden
    C. Gemeenschappelijke tuin
    D. Dag recreatief gebied (bijvoorbeeld een dierentuin, openluchtmuseum of pretpark)
    E. Agrarisch gebied (bijvoorbeeld grasland, tuinland, bouwland of een boomgaard)
    F. Bos
    G. Andere plekken in de openbare ruimte

19. In de vorige vraag heeft u een aantal openbare ruimten gemarkeerd die u vaker dan één keer per maand gebruikt. Kunt u aangeven waarom u deze ruimten vaker gebruikt?

U kunt hierbij denken aan de kenmerken van de openbare ruimte, zoals het onderhoud, de faciliteiten en de afstand, aan uw ervaring van de ruimte, zoals uw beleving van veiligheid, of aan de mensen die de ruimte bezoeken. Alle overige redenen die voor u van belang zijn om de aangegeven plekken te bezoeken, kunt u bij deze vraag benoemen.

20. Kunt u op de kaart aangeven welke openbare ruimte u (bijna) nooit bezoekt?
    H. Park en plantsoen
    I. Sportvelden
    J. Gemeenschappelijke tuin
    K. Dag recreatief terrein (bijvoorbeeld een dierentuin, openluchtmuseum of pretpark)
    L. Agrarisch terrein (bijvoorbeeld grasland, tuinland, bouwland of een boomgaard)
    M. Bos
    N. Andere plekken in de openbare ruimte

21. In de vorige vraag heeft u een aantal openbare ruimten gemarkeerd die u zelden of nooit bezoekt. Kunt u aangeven waarom u deze ruimten zelden gebruikt?

U kunt hierbij denken aan de kenmerken van de openbare ruimte, zoals het onderhoud, de faciliteiten en de afstand, aan uw ervaring van de ruimte, zoals uw beleving van veiligheid, of aan de mensen die de ruimte bezoeken. Alle overige redenen die voor u van belang zijn om de aangegeven plekken niet te bezoeken, kunt u bij deze vraag benoemen.

Deel 4: Lichamelijke activiteit

Het meeste werk is gedaan! Nu volgen de laatste twee vragen over de routes die u vaak gebruikt in uw wijk voor recreatieve en transportdoeleinden.

22. Kunt u op de kaart één (of meer) fiets-/wandelroutes aangeven die u één keer per week of vaker gebruikt voor uw plezier en één (of meer) routes die u gebruikt als transport voor andere doeleinden (bijvoorbeeld om naar school, werk, supermarkt of kerk te gaan)?

Routes voor plezier/ recreatie: bijvoorbeeld het bezoeken van een park, het uitlaten van de hond, het bezoeken van familie en vrienden in de openbare ruimte, etc.
Routes voor transport: routes om van en naar specifieke plekken te gaan, zoals uw werk, school, kerk, supermarkt, etc.

23. Waarom gebruikt u de aangegeven routes één keer per week of vaker?

U kunt hierbij denken aan de kenmerken van de routes, zoals het onderhoud van fiets-en wandelpaden, de faciliteiten op de route, aan uw ervaring van de route, zoals uw beleving van veiligheid, of aan de mensen die deze route ook gebruiken. Alle overige redenen die voor u van belang zijn om de aangegeven routes te gebruiken, kunt u bij deze vraag benoemen.

Appendix C: Categorization of public space in the Netherlands

Table C1 shows the type of public spaces that are distinguished by CBS. Since 1996 CBS divides the land use of the Netherlands in several groups, that are divided in categories (Centraal Bureau voor de Statistiek, 2008). For each city the total area per category of land use is measured (Centraal Bureau voor de Statistiek, 2018). Since the total land use categorization includes many categories that cover a small area of 's-Hertogenbosch, only the most occurring land uses in 's-Hertogenbosch are shown in Table C1.

Table C1: Categorization land use (based on CBS, 2008)

Categories (Dutch)	Description (Dutch)	Categories (English)	Description (English)
Park	Gebied met groenvoorziening in gebruik voor ontspanning (gazons, speel-en ligweiden, paden, bloemperken).	Park	Area with green for recreational purposes (lawns, playfields, trails, flowerbeds), intended for relaxation.
Sportveld	Gebied in gebruik voor sportactiviteiten (terrein voor sportveld, zwembad, sporthal en manege).	Sport fields	Area intended for sport activities (sport fields, swimming pool, sports hall, ice skating, tennis courts, golf courts).
Volkstuin	Gebied voor niet-commerciële sier-en groenteteelt (schooltuin, volkstuin).	Community garden	Area intended for non-commercial vegetable growing and floriculture (school and community garden).
Dagrecreatief gebied	Gebied in gebruik voor dagrecreatie (dierentuin, openluchtmuseum, pretpark).	Day recreational area	Area intended for day recreation (zoo, open air museum, amusement park, playground, picnic area, children's farm).
Agrarisch gebied	Agrarisch gebied niet in gebruik voor glastuinbouw.	Agricultural area	Agricultural area intended for non-greenhouse horticulture (grassland, gardening, orchard).
Bos	Gebied begroeid met bomen bestemd voor houtproductie en/ of natuurbeheer.	Forest	Area overgrown with trees for wood production or nature.

Appendix D: Online distribution of questionnaire

This Appendix shows the websites and webpages that were used to distribute the questionnaire online. The offline distribution of the questionnaire, through appointments with community and elderly care centres, has previously been explained.

Table D1: Webpages used for online distribution

Maaspoort
https://www.facebook.com/wijkmanagermaaspoort/
https://www.facebook.com/groups/1378280539100560/
https://www.facebook.com/maaspoortnieuws/
Binnenstad
https://www.facebook.com/wijkmanager.binnenstad.shertogenbosch/
https://www.facebook.com/groups/174479666245477/?ref=group_browse
Rosmalen Zuid
https://www.facebook.com/maliskamp/
https://www.facebook.com/wijkmolenhoek.rosmalen/

Appendix E: Flyer for distribution of questionnaire

This Appendix shows the flyer that is designed to distribute the questionnaire among residents of Maaspoort, Binnenstad and Rosmalen Zuid.

UW MENING TELT!

Hoe kunt u helpen?

1. Open uw internetbrowser en ga naar https://app.maptionnaire.com/nl/6364/

2. Beantwoord 23 vragen over uw leefomgeving en denk mee!

3. Na 15 tot 20 minuten heeft u de vragenlijst voltooid.

Hartelijk dank voor het invullen van de enquête!

Denk mee over de ontwikkeling van uw woonwijk.

Link naar de website om de enquête in te vullen:
https://app.maptionnaire.com/nl/6364/

Beste bewoner,

U bent van harte uitgenodigd om deel te nemen aan het Master onderzoek van de Technische Universiteit Eindhoven naar het gebruik van openbare ruimte in drie wijken van 's-Hertogenbosch. Het doel van dit onderzoek is om inzicht te krijgen in de kenmerken van de openbare ruimte die uw wijk aantrekkelijk maken en u als bewoner tevredenstellen.

U neemt deel aan een enquête waarin aan u vragen zullen worden gesteld over uw persoonskenmerken, uw tevredenheid met de openbare ruimte in uw wijk en het gebruik van deze openbare ruimte. U dient tenminste 18 jaar oud te zijn om deel te nemen aan dit onderzoek en u dient woonachtig te zijn in één van de volgende wijken van 's-Hertogenbosch: De Binnenstad, Maaspoort of Rosmalen Zuid. Door deel te nemen aan de enquête draagt u bij aan de ontwikkeling van een aantrekkelijke woonomgeving voor jong en oud!

Hartelijk dank!

Lisanne Bergefurt
a.g.m.bergefurt@student.tue.nl

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

PLANTERRA
THUIS IN DE OPENBARE RUIMTE

Appendix F: Informed consent form (Dutch)

Beste respondent,

U bent van harte uitgenodigd om deel te nemen aan het onderzoek van de Technische Universiteit Eindhoven naar het gebruik van openbare ruimte in drie wijken van ’s-Hertogenbosch. Het doel van dit onderzoek is om inzicht te krijgen in de kenmerken van de openbare ruimte die uw wijk aantrekkelijk maken en u als inwoner tevredenstellen.

Gang van zaken tijdens het onderzoek

U neemt deel aan een enquête waarin aan u vragen zullen worden gesteld over uw persoonskenmerken, uw tevredenheid met de openbare ruimte in uw wijk en het gebruik van deze openbare ruimte. Ook wordt u gevraagd om punten en routes te markeren op een kaart, om inzicht te krijgen in de beweegredenen van respondenten om routes en plekken te gebruiken in uw wijk. U dient tenminste 18 jaar oud te zijn om deel te nemen aan dit onderzoek en u dient woonachtig te zijn in één van de volgende wijken van ’s-Hertogenbosch: De Binnenstad, Maaspoort of Rosmalen Zuid. De enquête bestaat uit verschillende onderdelen, waarin u eerst gevraagd wordt om persoonlijke eigenschappen te noteren, zoals uw leeftijd, inkomen en geslacht. Vervolgens worden vragen over uw gebruik van openbare ruimte in uw wijk gesteld.

Potentiële risico’s en ongemakken

Er is enig ongemak verbonden aan uw deelname aan deze studie, vanwege de gevoelige aard van gegevens die worden verzameld. U hoeft geen vragen te beantwoorden die u niet wilt beantwoorden. Uw deelname is vrijwillig en u kunt uw deelname op elk gewenst moment stoppen. U wordt op geen enkele manier gedwongen om deel te nemen aan dit onderzoek.

Vergoeding

U ontvangt voor deelname aan dit onderzoek geen vergoeding. Door deel te nemen aan dit onderzoek zult u meer inzicht krijgen in gebiedskenmerken die mogelijk het gebruik van openbare ruimte bepalen. Dit inzicht kan de besluitvorming van gemeenten beïnvloeden, door vergaarde kennis over gebruik van openbare ruimte in uw wijk.

Vertrouwelijkheid van gegevens

Uw privacy is en blijft maximaal beschermd. Er wordt op geen enkele wijze vertrouwelijke informatie of persoonsgegevens van of over u naar buiten gebracht, waardoor iemand u zal kunnen herkennen. Voordat de onderzoeksgegevens naar buiten gebracht worden, worden uw gegevens geanonimiseerd. Uw leeftijd, geslacht en inkomen wordt gecategoriseerd, waardoor gegevens niet naar u herleidbaar zijn. Kaarten met uw thuislocatie worden samengevoegd met kaarten van overige respondenten, zodat een geaggregeerde kaart met verschillende kaartlagen ontstaat en ook deze gegevens niet naar u herleidbaar zijn. Bij start van het onderzoek worden uw gegevens gepseudonimiseerd ofwel versleuteld. Op deze manier kan wel worden onderzocht wat u aangeeft in de enquête, maar kan niet herleid worden wie u bent. De onderzoeker is zelf verantwoordelijk voor dit pseudoniem en de sleutel en zal uw gegevens niet delen met onderzoekers buiten de onderzoeksgroep. In een publicatie zullen anonieme gegevens of pseudoniemen worden gebruikt. De documenten die in het kader van deze studie worden verzameld, worden opgeslagen op een beveiligde locatie bij de Technische Universiteit Eindhoven en op de beveiligde (versleutelde) computer van de onderzoeker. De onderzoeksgegevens worden indien nodig en alleen in anonieme vorm ter beschikking gesteld aan personen buiten de onderzoeksgroep, bijvoorbeeld voor aanvullende analyses.

Vrijwilligheid

Deelname aan dit onderzoek is geheel vrijwillig. U kunt uw medewerking aan dit onderzoek te allen tijde stoppen, of weigeren dat uw gegevens voor dit onderzoek mogen worden gebruikt, zonder opgaaf van redenen. Dit betekent dat er geen gevolgen zullen zijn als u voorafgaand aan het onderzoek besluit om van deelname af te zien. Tevens kunt u tot vijf dagen na het interview alsnog de toestemming intrekken die u gegevens hebt om gebruik te maken van uw gegevens. In deze gevallen zullen uw gegevens uit onze bestanden worden verwijderd en vernietigd. Het stopzetten van uw deelname heeft geen nadelige gevolgen. Als u tijdens het onderzoek, na bedenktijd van vijf werkdagen, besluit om uw medewerking te staken, zal dat eveneens op geen enkele wijze gevolgen hebben voor u. echter, de gegevens die u hebt verstrekt tot aan het moment waarop uw deelname stopt, zal in het onderzoek gebruikt worden, inclusief de bescherming van uw privacy zoals hierboven beschreven. Er worden uiteraard geen nieuwe gegevens verzameld of gebruikt. Als u besluit om te stoppen met deelname aan het onderzoek, of als u vragen of klachten heeft, of uw bezorgdheid kenbaar wilt maken, of een vorm van schade of ongemak vanwege het onderzoek, neemt u dan alstublieft contact op met de onderzoeker, Lisanne Bergefurt: a.g.m.bergefurt@student.tue.nl.

Toestemmingsverklaring

Door akkoord te gaan, geeft u aan dat u tenminste 18 jaar oud bent, dat u goed geïnformeerd bent over het onderzoek, de manier waarop de gegevens worden verzameld, gebruikt en behandeld en welke eventuele risico’s u zou kunnen lopen door te participeren in dit onderzoek.

Indien u vragen hebt, geeft u bij akkoord aan dat u deze vragen hebt kunnen stellen en dat deze vragen helder en duidelijk zijn beantwoord. U geeft aan dat u vrijwillig akkoord gaat met uw deelname aan dit onderzoek.

1. Ik ben geïnformeerd over het doel van het onderzoek. Ik kon aanvullende vragen stellen en deze zijn voldoende beantwoord. Ik heb voldoende tijd gehad om over mijn deelname te beslissen en ik weet wat mijn deelname voor mij betekent.
2. Ik weet dat deelname volledig vrijwillig is. Ik ben op de hoogte dat ik ieder moment kan beslissen om toch niet mee te doen. Daar hoef ik geen reden voor te geven. Ik word op geen enkele manier gedwongen om deel te nemen aan het onderzoek.
3. Mijn deelname houdt in dat ik word bevraagd in de enquête. Het invullen van de enquête zal ongeveer 10 tot 15 minuten duren.