Urban design for physical activity

Graduation Report | November 19, 2020

Susanne E. M. van Rijn

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An exploration of the use of quantitative statistics to determine the role of urban design of public space in Westland, the Netherlands, in encouraging adolescents to be more physically active

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[All images are made by the author, unless stated differently.]

Acknowledgements

First of all I would like to thank my mentor team Arie Romein and Leo van den Burg. Arie for his enthousiasm in the analytical part, and for his nuanced questions and comments on the methodology. I have learned so many new things regarding statistics and doing quantitative research. Leo for his instinct to push the design part even further to develop not only a research methodology, but one suitable for designers too. This has made my graduation thesis a complete and wrapped up project.

When I got to the point that I wanted to do a quantitative study among children, I had not realised that it came with so many (important) side issues. Fortunately during the entire project there have been people who advised me and wanted to share their knowledge. Thanks to everyone who has helped me figure this all out and get to this point. From of course all respondents to the people who let me use their network to distribute my survey and advised me on the software, privacy issues and statistical modeling.

A big thanks to my family and friends, you were all very important to me during my entire studies. Thanks for all the distractions, laughs, supporting talks, your interest, shared meals, and warm hugs when they were still allowed.

And finally my parents, always cheering for me and cheering me up when necessary. Thanks for letting me crash at your place my when I needed it. Thanks for everything. ♥

Susanne van Rijn,
Wateringen, The Netherlands
November 2020

Glossary

Attribute

"A quality, character, or characteristic ascribed to someone or something." (Merriam-Webster, n.d.-a)
In this graduation thesis a characteristic of the physical environment, e.g. of (green) public spaces, as used in the choice based conjoint analysis and the spatial analysis.

Choice based conjoint analysis

A method often used in product research or consumer behaviour research to estimate the relative importance of specific attributes of a product or service over other attributes (partially based on Steenkamp, 1985). Used in a survey where respondents get to choose their preferred public space from a set of two alternatives and a no choice alternative. In the thesis simultaneously used with conjoint experiment or choice based conjoint experiment.

Green public space

A component of the physical environment with elements of vegetation, and not merely the vegetation itself. It is a specific type of public space with a large share of vegetataion, and where the green areas can be used (partially based on Schipperijn, Bentsen, Troelsen, Toftager, & Stigsdotter, 2013, p.110).

Physical Activity

"Any bodily movement produced by skeletal muscles that requires energy expenditure" (World Health Organization, 2010, p.53). This includes active recreation, active transportation, household activities and occupational activities (based on Pratt, Macera, Sallis, O'Donnell, & Frank, 2004). A specific component of physical activity is exercise: "A subcategory of physical activity that is planned, structured, repetitive, and purposeful in the sense that the improvement or maintenance of one or more components of physical fitness is the objective." (World Health Organization, 2010, p.52). Active recreation and transport are the scope of activities in the analysis. For the transforation the emphasis is placed on active recreation.

Public Space

By all means 'public space' in this thesis is not all space that is publicly accessible. It consists of outdoor spaces that are public and physically accessible, and are of reasonable size to engage in physical activity, such as parks, playing fields, and squares. It consists of spaces to stay in, i.e. streets are excluded, as they are more continuous of nature.

To develop a complete profile of the activity behaviour of the respondents, all spaces to engage in physical activity are included in the survey questions. Also included streets, school yards and indoor sports facilities. These are not included in the rest of the thesis. To increase the possible impact of the thesis, non-green public spaces are included in the analysis and transformation phase.

Summary

The World Health Organization (WHO) showed that in 2016 over 80% of adolescents worldwide are not active enough (WHO, 2019b). The Netherlands is no exception to this. Although activity levels are increasing, the major share of adolescents in the Netherlands are still physically too inactive (CBS, 2019). In Westland, this number increases to 86% inactive adolescents in 2015 (as compared to 76% in the Netherlands in 2016)[1] (Keetman et al., 2016).
Inactivity is seen as a major public health threat as it is associated with 8% of the deaths in high-income countries directly and to over 30% indirectly (WHO, 2009). Physical activity contributes to a better general health, and can contribute to reducing the risk at several diseases, such as diabetes, depression, and several types of cancer (World Health Organization, 2010, p.10).

Physical activity behaviour is complex to understand and change, as it is influenced by a high variety of variables. Variables include aspects of the physical environment, such as facilities and networks, personal variables, and variables of the social environment. The composition of the public spaces can facilitate or hinder adolescent physical activity behaviour. Although research has been increased on this topic, the associations of specific environmental attributes with adolescent physical activity behaviour often remain inconsistent (e.g. Ding, Sallis, Kerr, Lee, & Rosenberg, 2011). Furthermore do Edwards, Hooper, Knuiman, Foster, & Giles-Corti (2005) state that it is unclear what specific park characteristics are stimulating adolescents to visit green spaces to be physically active. Green spaces are assumed to contribute to positive health, partially through facilitating physical activity behaviour (Hartig et al., 2014). As adolescents in Westland are less active than the Dutch average, and living in the municipality with the least amount of green space (Bakker, 2017) and the highest amount of built up surface (Dollen, 2019), this location is selected as test case. It is researched how a square located in Westland can be transformed to better meet the spatial demands of adolescents for physical activity with use of quantitative analysis.

A literature review is used to identify attributes of (adolescent) physical activity behaviour. The review covers two perspectives: (1) the use of green public space for physical activity and (2) adolescent physical activity behaviour. A digital survey is developed for adolescents to find out their current physical activity behaviour and motivation, but more importantly their demands for an active friendly living environment. Their preferences for the use of public spaces to be physically active are researched using a choice based conjoint experiment, which was a part of the survey. With this type of experiment the relative importance of the ten spatial attributes for adolescent physical activity in outdoor public space is estimated. Each respondent of the survey got five choice sets to select their preferred public space to be active in. The survey was distributed digitally among adolescents and retrieved 65 useful responses. With these responses a multinomial logit regression analysis (MNL) is executed using PandasBiogeme. The analysis is run with 309 observations from the responses.

The MNL estimated the value of each attribute and from there the total utility could be calculated for all alternatives. Of the ten spatial attributes, five showed significant with $p < 0.1$. Above all respondents preferred the presence and variety of vegetation to visit public spaces for physical activity. Opportunities for physical activity should be present, physical barriers where respondents have to wait for should be absent. Respondents furthermore preferred their home to be within a five minut walk. And it seemed important that the entire public space is well-lit.
Some of the non-significant showed different associations than expected. For example, where literature on the use of green space for physical activity states that water features are positively contributing to the attractiveness of the green space, and with that to the use of it for physical activity, the MNL showed that respondents prefer the absence of water features. Possible explanations are the sample size being too small or not representative enough. Or the fact that these attributes were retrieved from the literature that was not targeting a specific user group, i.e. adolescents.

The importance or preferred absence of the five significant attributes was used to transform a square in Westland. This to illustrate how this research method into user preferences can give input for the design practice as well. A square in Kwintsheul was selected because it was assumed that a transformation could have a large impact on the composition of space and especially on the functionality of the space for adolescent physical activity behaviour. In the transformation special attention has been paid to the presence and variety of vegetation, while still developing a safe space. Facilities for active recreation are added specifically targeting the adolescents.

The conclusion from this thesis is first that a choice based conjoint analysis can be a valuable method to use in urban research and design, as one can identify user preferences before actually transforming the physical environment. However it is important to carefully define and use the attributes for the analysis, and to avoid misinterpretation as much as possible. As for the results, they give some valuable starting points for urban design, but it remains a starting point. There still is room to play for a designer. Important is that the transformation fits not only the spatial demands, but also the existing urban fabric. A balance should be sought to avoid conflicting attributes. But overall remains that there certainly are spatial characteristics that could contribute to get adolescents physically more active.

1 For Westland, 18-year olds are included in the adolescents, where they are included in the adults for the Netherlands as a whole.

PART 01 | INTRODUCTION

PART 02 | THEORY

PART 03 | RESULTS

PART 04 | CONCLUSION

Part 01 is the assignment for AR3U013 Analytical Methods of Urban Planning and Design. Paragraph 3.2 is the assignment for AR3U023 Theories of Urban Planning and Design. The assignment for AR3U040 Graduation Orientation is included as Appendix A-10.

Nature area in between Wateringen and Kwintsheul (2019).

In this first part the key components of this graduation thesis are introduced followed by the approach. The personal motivation leads to three concepts that are intertwined and form the basis of the thesis. These three concepts are used to explain the problem field, resulting in a problem statement. The importance of the project in a broader context is explained in the Societal and Scientific Relevance.
In chapter two, the approach of the graduation thesis is explained. From the Problem Statement in chapter one a main Research Question is derived with corresponding objectives. It is shown how the sub questions are related to the key components adolescents, physical activity, and public space, and how they contribute to answering the main research question. Research limitations and ethical considerations are given, together with how they are dealt with in this thesis.

PART 01 | INTRODUCTION

01 | Introduction to the Topic

1.1 Personal Motivation

When starting my graduation project, I found it difficult to come up with a specific research topic right away. I have many interests, in many different topics. But what I came to learn these last years is that I find it important that urban design is useful and relevant. In my opinion this can only be done when users are actively involved in the process. Apart from that I am driven to get the best out of people. To help them grow as a person and to create an environment in which they can thrive. In my side job and volunteering activities I do this in a more social way, but within this graduation thesis, I have the opportunity to explore the spatial aspect of it.

From this drive it was a small step to human behaviour and the influence of the physical environment on said behaviour. Behaviour is also about how people use the space present and I found it intriguing to research how this space can accommodate people to get the best out of themselves, and to help them be their healthiest and happiest self. Because of my intention to do something that is relevant to society and not just 'nice' or 'beautiful' I came to the topic of physical activity. Large shares of the entire population are physically too inactive. However, over the past years, adolescents are shown to be the least active.
I found out that the adolescent population of Westland, the Netherlands, is even less physically active than average in the Netherlands. The local Health Care Institution (GGD Haaglanden) have defined six key messages for the development of Westland, in which a healthy living environment and a positive growth of citizens play an important role (GGD Haaglanden, 2015, p.11).

Growing up in Westland myself, I have been intrigued by its urban form of housing in between a almost industrial landscape of greenhouses. When I found out that Westland was the least green municipality inside built areas in the Netherlands (Booister, 2017), and that it has the highest percentage of built up surface in the country (Dollen, 2019), this formed an interesting case for this project.

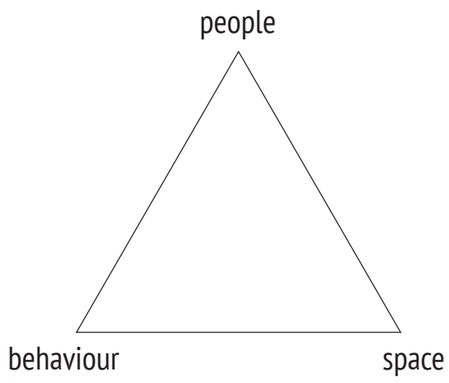


Figure 1 | Key components of the thesis

1.2 Reading Guide

In this report the process and story of the graduation project is described. The report is divided into four parts with 8 chapters. In the first part, the main themes of this graduation thesis are introduced in relation to each other. The problem field at the cross road of these three topics is elaborated on, leading to a problem statement to work with in the rest of the thesis. The societal and scientific relevance show why the project has value in doing.

The second chapter 'Methodology' shows the methodological approach for the thesis. From the problem statement, research questions and objectives are derived. All sub questions relate to one or more topics and variables within the thesis. All variables are visualised in the conceptual framework, together with their relations. This shows the complexity of the topic, and enables to get a better understanding of the scope of the thesis. The methods are explained and related to the sub questions and main objectives. It is shown in the methodological framework how these methods and questions relate to each other, and what is the outcome of each of them. The research limitations show the boundaries of the thesis. And ethical considerations stated together with how these are dealt with.

The second part consists of the theoretical framework and the translation for the use in the survey. The literature review in chapter three is based on two perspectives: (1) adolescent physical activity behaviour, where vegetation is one of the variables; and (2) the relation between green space use and physical activity behaviour in general. Paragraph 3.2 is the assignment for AR3U023 Theories of Urban Planning and Design and somewhat adapted to fit in the report. The review of literature has lead to a selection of ten specific spatial attributes. Those are presented in chapter four. It is explained how design is used to translate them into a choice based conjoint experiment.

Part three presents the results of the multinomial logit regression analysis (MNL) and the transformation of these results. The sample is described and a comparison of the results with the reviewed literature is made in chapter five. This chapter shows which of the spatial attributes are more important than others for adolescents to be active in outdoor public space. The transformation of a specific public space is described and displayed in chapter six. The test case is selected based on preliminary research findings and assessed first. Then the MNL results are used to transform the space to illustrate how such method can be used in design practice as well.

Part four consists of the concluding remarks. It starts with the conclusion, answering the main research question and giving recommendations for general practice and for further research. In chapter 8 the project and process is reflected upon.

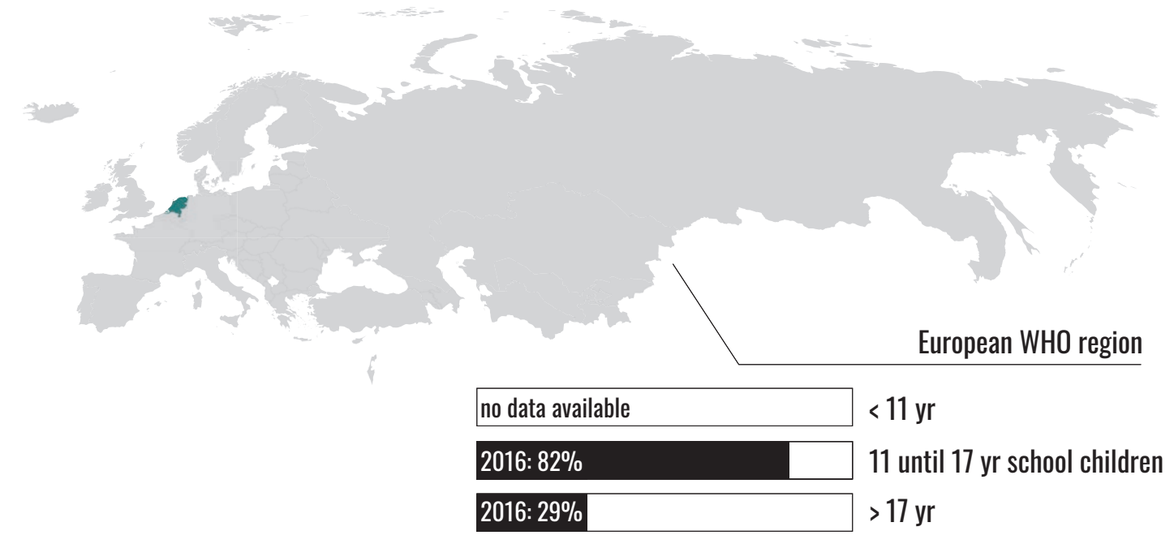


Figure 2 | Percentage of population that is inactive

1.3 Problem Field

Physical inactivity as global threat to public health

A large share of the worldwide population is physically too inactive and has been already for years. Figure 2 shows to what extent physical inactivity is present in the European region of the World Health Organization (WHO). At all scales of Europe, the Netherlands and the municipality of Westland it becomes clear that too many people are engaging in too little physical activity. What is remarkable is that adolescents are significantly less active than adults. For the entire European WHO region, over 80% of the school going adolescents is not active enough where just under 30% of adults is too inactive (World Health Organization, 2019b). The Netherlands and Westland show similar numbers.

The graph in Figure 3 shows the trendlines of the Dutch population meeting the physical activity guidelines from 2001 onwards. As shown in Figure 2 already adolescents are at risk. This sub population group shows another alarming thing: where all other groups show stable or upward trendlines, the group of adolescents show a fluctuating trendline. With some higher percentages around 2007 and 2012, there is a decline visible right after these highs. The exact guidelines can be found in Appendix A-1.
An explanation in the decrease of activity levels from child to adolescent might be the big changes in their lives from primary school to high school resulting in different ways to spend their time and less time to spend (Sociaal en Cultureel Planbureau & Mulier Instituut, 2018). However, this does not directly mean that there is nothing to do about it. Studies show that adolescents have more free time than adults in their working life (Wennekers, Roeters, van den Broek, & Pulles, 2018) and adults show to be more active than adolescents. Another explanation of the high inactivity levels may be the popularity of screens and screen-viewing hobbies such as smartphones and Netflix (based on Redactie Gezond, 2019).
Adolescents are the target group of this graduation thesis, as this is the sub population group with the highest risk at the moment. This is the group that needs to change their behaviour the most. Sallis, Prochaska and Taylor (2000) show in a review of studies on variables influencing child and adolescent physical activity behaviour, that previous physical activity levels are often associated with current levels. This implies that encouraging adolescents of today to be active enough will increase the chance that they will remain active enough when growing up. Leaving this target group untouched will risk a larger share of inactive adults in the future, when diseases directly or indirectly caused by physical inactivity often occur.

Physical inactivity is identified by the WHO as the number four risk factor for deaths in high-income countries (World Health Organization, 2009, p.10). Inactivity can be related to 8% of the deaths, it follows (1) tobacco use – 18%, (2) high blood pressure – 17%, and (3) overweight and obesity – 8% (World Health Organization, 2009, p.11). The WHO connect physical activity to both overweight and blood pressure, by stating that "energy expenditure" is largely influenced by the level of physical (in-) activity and that an imbalance in energy expenditure relates to being overweight or obese (2009, p.38). Physical activity could contribute to lowering risks on both physical and mental health aspects. Diseases such

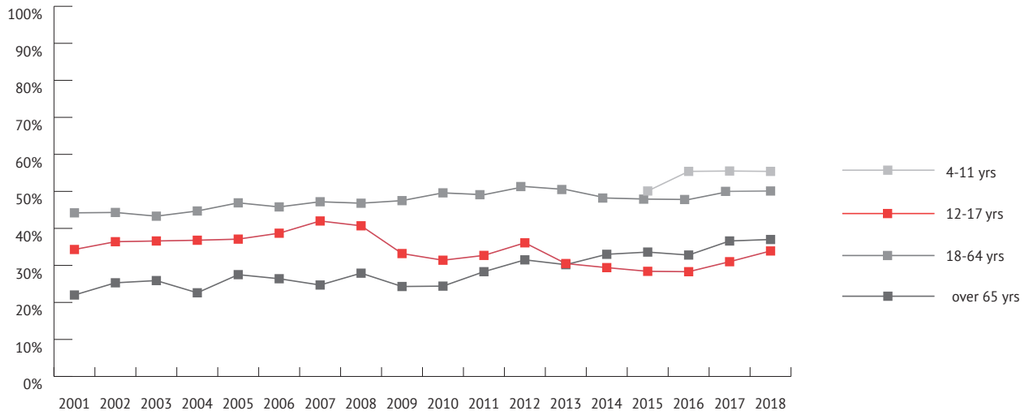


Figure 3 | Trends in percentage of Dutch population meeting new physcial activity guidelines (based on data from CBS & RIVM, 2018).

as diabetes type 2, several types of cancer, cardiovascular disease and depression could benefit from engaging in physical activity (World Health Organization, 2010, p.10). This means that inactivity is not only a risk factor in itself, but can be related to three out of four risk factors stated above, to some extent related to almost 33% of deaths in high-income countries. Physical activity can thus be seen as a crucial element of healthy people and inactivity is thus a realistic threat to public health on multiple scale levels. Studies show that from 2012 to 2016 there has not been made much progress in worldwide activity levels (as explained in Scherder, 2020). In these uncertain times where a pandemic causes people to stay at home, but asks for a healthy immune system, physical activity is becoming much more important (Scherder, 2020). Solutions should be sought for in all disciplines possible to contribute to increase activity levels worldwide.

Physical activity behaviour – an ecological model

Human behaviour is complex to explain and thouroughly understand. Physical activity behaviour is no exception to this. Researches have tried to clarify behaviour by developing several models of specific types of behaviour. Traditional models and theories of behaviour predominantly focus on individual characteristics and the close social circle. On the other hand, ecological models of behaviour take into account broader influences (Sallis & Owen, 2015). It is a way to look at behaviour while also including attributes of the physical environment. Ecological models are used to understand "people's interactions with their physical and sociocultural surroundings" (Stokols, 1992 as cited in Sallis, Cervero, Ascher, Kraft & Kerr, 2006, p.43). Because of this more complete and holistic look on behaviour, and the inclusion of variables concerning the physical environment, this type of model is particularly suitable to use when researching the role of the physical environment on human behaviour.

Sallis et al. (2006) have developed an ecological model of physical activity behaviour. This original model can be found in Appendix A-2. In this thesis the model has been adapted to the theory findings (chapter three), and is shown in Figure 4. Sallis et al. (2006) have defined seven so-called levels of influence relevant to physical activity behaviour:

1. Intrapersonal characteristics
2. Perceived environment
3. Behaviour Settings
4. Policy Environment
5. Information Environment
6. Socio-cultural Environment
7. Natural Environment

(Sallis et al., 2006)

All seven levels of influence are related to a specific type of activity: (1) leisure, (2) occupation, (3) transport, and (4) home based activities. How these levels influence physical activity behaviour can vary per type of activity. The model shows a large variety of influencing variables. Apart from personal characteristics like age, ethnicity and gender, support from others appears to influence the amount adolescents are active as well. The physical environment can be found in the levels of the perceived environment (2) and of the behaviour settings (3).Behaviour settings are understood as the characteristics of a place, together with the accessibility of said place (Sallis et al., 2006). The perceived environment is much more about the experience of a place or network.

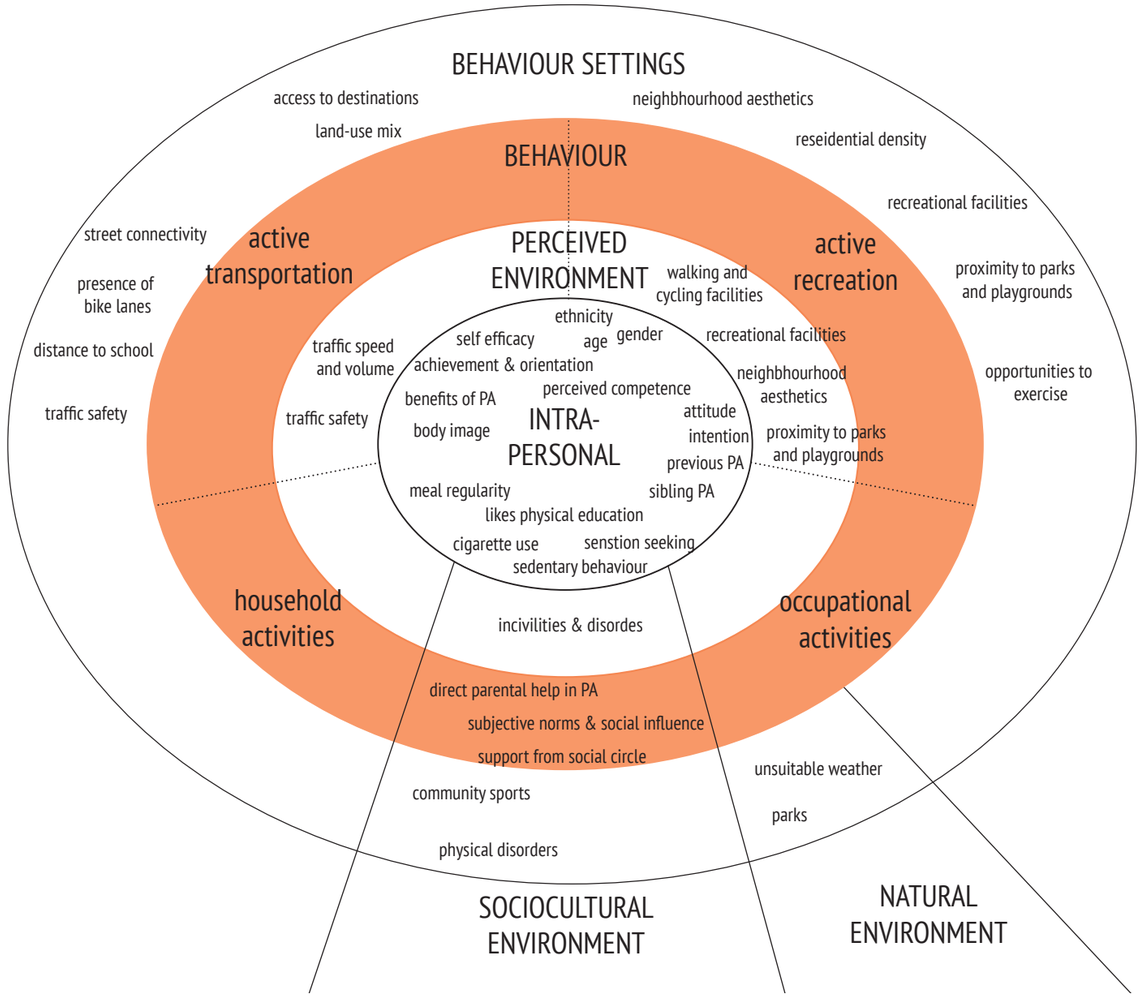


Figure 4 | Adapted ecological model for adolescent physical activity behaviour. Based on the original by Sallis et al. (2006), and adjusted with the findings from the literature review (based on: Ding et al., 2011; Davison & Lawson, 2006; and Sallis, Prochaska, & Taylor, 2000). See Appendix A-3 for an overview of the attributes per review.

As Figure 4 displays, research has already shown a high variety of environmental variables related to adolescent physical activity behaviour. Results are however often inconclusive on the exact relation. Davison and Lawson e.g. have predominantly found from prior empirical research that the perceived "proximity of playgrounds and parks" is positively related to children's levels of physical activity (2006, p.8). Ding et al. however have found an inconsistent link with perceived characteristics of parks, such as accessibility and proximity or no link at all (2011, p.449). This inconsistency regarding a similar variable demonstrates the urge to look more closely at the local spatial context. Furthermore do studies often differ in methodological approach: e.g. some studies use reported physical activity levels, where other use measured levels. Also differences in how the environmental variables are measured increase complexity. These methodological differences make it complex to compare studies and extract specific components of the physical environment that are key to adolescent physical activity behaviour to use in urban design. Although specific components of the physical environment can influence individual behaviour, Bedimo-Rung, Mowen and Cohen state that the transformation of the physical environment has also has larger impact, as it can "make it easier for individuals to be physically active" (2005, p.159). Where behavioural change mainly is an individual process, a transformation of the physical environment can reach entire user groups at once (Bedimo-Rung et al., 2005). In a Dutch research on national sports trends is shown that for adolescents between 16 and 20 years old (no numbers available for younger ones) the main barrier to be active is a lack of time (Visser, Duijf, & van den Dool, 2019). When the physical environment is encouraging people to be active by e.g. having sufficient and attractive facilities, people could be tempted to be active when they pass through a space e.g. from work or school. They don't need to go there explicitly, but can incorporate it in daily life.

Public space as a component of the physical environment

Public space is a key component of the physical environment to be used for outdoor physical activity. The public spaces with large shares of vegetation or an important role for green space, green public spaces, are related to physical activity behaviour as well, according to Hartig, Mitchell, De Vries and Frumkin (2014). They argue that green spaces can offer places for specific activities and draw people outside (Hartig et al., 2014). Places such as parks can present attractive routing networks for people to walk, or facilitate play and sports through the composition of the space. Giles-Corti et al. (2005) have found furthermore that using green public spaces often meant that people were more probable to achieve specific levels of physical activity (see as well Lee & Maheswaran, 2011). The WHO (2016) has related green spaces to physical activity, by identifying physical activity as one of nine mechanisms through which green space could influence health.

It remains however unclear what specific characteristics of parks attract adolescents to go there and engage in physical activity (Edwards, Hooper, Knuiman, Foster, & Giles-Corti, 2005). They argue that for adults these types of research have been done, but not for adolescents (Edwards et al., 2005). It is expected that different sub groups of people are attracted by different

Figure 5 | Westland situated in the West of the Netherlands (based on: Google, n.d.).

Figure 6 | Built form of Westland.

characteristics to engage in physical activity. Edwards et al. (2005) furthermore show with their study that adolescents not always use the closest park. This suggests that proximity of a park is subordinate to park characteristics. Thus the form and opportunities for use of green public spaces might be more important to concentrate on than the distribution of green public spaces in an area. Therefore the focus of this thesis is predominantly on the qualities of public spaces instead of the qualities of the network of public space.

The case of Westland

To test the research findings and translate the results into practice, a test case was selected. As shown in previous paragraphs adolescents in Westland are researched to be less active than average in the Netherlands. Furthermore was it presented to be the municipality with the least green space within the urban settlements in the country (Bakker, 2017).

Westland is a municipality located in the western part of the Netherlands, which can be seen in the Figures 2 (middle) and 5. It is surrounded by the grasslands of Midden-Delfland, the bigger cities of Den Haag and Rotterdam in the North and South-West, and the North Sea in the North-West. With over 105,000 inhabitants in 2016 (Centraal Bureau voor de Statistiek, 2017), Westland can be seen as a mid-size city in terms of its inhabitants. The urban form however shows that it is a collection of smaller villages embedded in an industrial and economical landscape of greenhouses, as is made visible in Figure 6. This agricultural sector not only has a large impact on the spatial structure, it is of great importance to the economy and wealth of Westland too (Kamer van Koophandel Den Haag & Rabobank Westland, 2008).

When looking at the density of the built form, it is not surprising that Westland recently showed to be the municipality with the highest percentage of built surface (Dollen, 2019). The areas for built surface, transportation and agriculture fill up over 80% of the land (Centraal Bureau voor de Statistiek, 2018). Considering the North Sea (outside water, see Figure 7), this leaves just over 10% for open space, including inland water, forest, and recreation spaces.

The assumption was that green public spaces positively contribute to increase adolescent physical activity levels. Therefore the redevelopment of a public space in Westland can have a large impact because of the current conditions. This makes it an intriguing case for the graduation project.

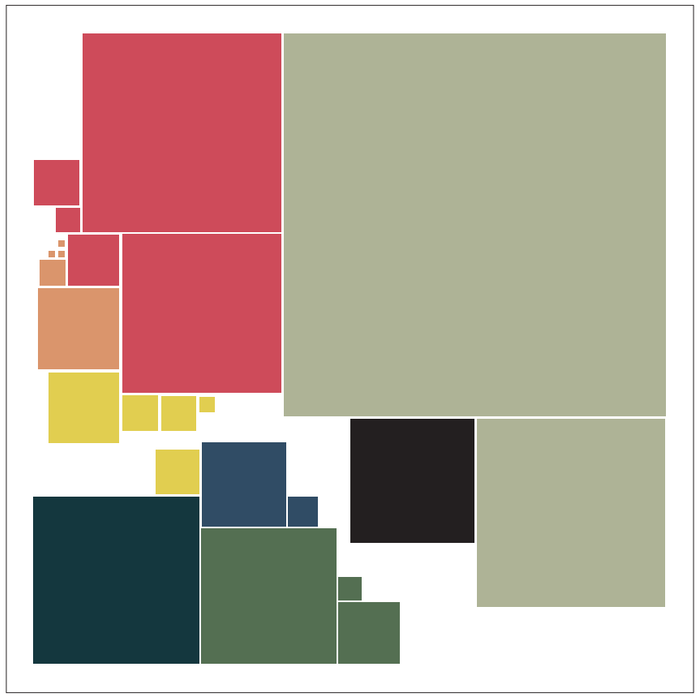


Figure 7 | Land use in Westland (based on data from Centraal Bureau voor de Statistiek, 2018). The surface of a square is the land use in ha, the separate squares are sub categories of the legend shown above.

1.4 Problem Statement

Physical inactivity is a large threat to public health, both on a global and on a local scale. It can be related to one third of deaths in high-income countries, as it contributes to high blood pressure and overweight. As a risk factor it increases the risk at diseases such as diabetes, depression and several types of cancer (World Health Organization, 2010). Being sufficiently active has multiple benefits, both on physical and mental health. Adolescents are the target group at risk, with worldwide over 80% of them not being active enough (World Health Organization, 2019a). Adolescents in the Netherlands show furthermore a fluctuating trendline. In Westland only 14% of the adolescents meet the national directive of minutes spent on physical activity in 2015, showing more alarming numbers (Keetman, et al., 2016).
Research has shown factors of the physical environment to be related to physical activity behaviour in adolescents (e.g. Davison & Lawson, 2006; Ding et al., 2011). However, empirical research has also shown inconsistencies in what spatial aspects are contributing to adolescent physical activity behaviour (see e.g. Bauman et al., 2012; Ding et al., 2011).

Differences in research findings, the necessity of an active lifestyle in current times, and the lack of this lifestyle among adolescents call for action in all fields. Urban design can contribute to this public health threat and an effort should be made for a working field where the development of an active friendly environment is the standard.

1.5 Societal Relevance

With a lot of positive health benefits from physical activity, both physical and mental, and inactivity being directly or indirectly associated with the causes of over 30% of deahts in high-income countries, inactivity is a clear threat to public health. It is thus important to contribute to solutions in all disciplines possible. It is suggested by several authors that "our response to the public health challenge of inactivity has not been as strong as is needed" (Kohl et al., 2012; Hallal et al., 2012; as cited in Reis et al., 2016, p.1345). This suggests that every step we take towards coping with inactivity and contributing to get people to become more active is important. It shows that it is important to adress physical activity in every discipline possible, not only within the health sector (Reis et al., 2016, p.1346).

Former head coach of the Dutch women's hockey team Marc Lammers has a motto to improve a team prestation by strengthening every aspect of it. Improving every aspect with two percent will also lead to an improvement of 100% when you improve several different elements (2010, p.51-52). Following this chain of thought, acknowledging that there are several aspects of the physical environment that can facilitate physical activity behaviour, and that physical activity behaviour is influenced by a high variety of variables, there is a certain relevance of developing active friendly environments, for all age groups.

With the high pressure on the space in Westland, and a large share of inactive adolescents, the relevance of the location is present too. The GGD Haaglanden (2015) acknowledge the importance of the physical environment in health issues, respected their key messages for Westland. One of these messages is focused on the development of a 'healthy living environment' (GGD Haaglanden, 2015, p.22). Another is focused on the development of youth in a positive way, focusing among other aspects on physical activity behaviour and the development of a safe physical environment (GGD Haaglanden, 2015). The survey in this thesis provides information on spatial attributes of public spaces that appear important for adolescents to be more physically active. As only 14% of the adolescents living in Westland are active enough (Keetman, Veltman, Dekkers, Rooseboom de Vries, & Berns, 2016) the value of the project in Westland is evident.

Note: In August 2020 new numbers by the CBS have been released on physical activity behaviour in the Netherlands (CBS & RIVM, 2020). These numbers show a percentage of just over 40 of adolescents aged 12 to 17 years meeting the physical activity guidelines. It is suggested that including physical education in the numbers is causing this increase (CBS & RIVM, 2020). Although this percentage is climbing, the relevance of the research remains in tact. Keep inspiring the entire population to become and remain active is a lifelong process. With just around 60% of adolescents being too inactive, there still is a group of young people to adress, especially in times of a global pandemic.

1.6 Scientific Relevance

The explanation of the complexity of physical activity behaviour in the chapter 1 and later on in chapter 3 shows that the physical environment is only one element of influence on adolescent physical activity behaviour. However, empirical research has shown many inconsistencies in what spatial aspects are contributing to adolescent physical activity behaviour (see e.g. Bauman et al., 2012; Ding et al., 2011). As an example some studies show a positive association between accessibility to, and density and proximity of parks, and physical activity as reported by adolescents while other studies show no association at all (Ding et al., 2011, p.448). Where Maas et al. (2008) additionally argue that the amount of green space has no influence on the percentage of people meeting the Dutch physical activity guidelines, they neither take the opportunities of this green space nor the reasons why people are physically active or not into account. They also say that the amount of green does have a positive impact on adolescents meeting physical activity guidelines, but they do not explain why and how this works (Maas et al., 2008).

These inconcistencies show the difficulty to develop interventions that are beneficial at multiple scales and in different spatial contexts. Because of its complexity and the influence of social and cultural variables, which vary per context, it is important to research the (environmental) variables in a specific local context, before designing for this context.

In this graduation thesis a quantitative research method from consumer behaviour research is used to extract and quantify user preferences. This can be a helpful method to use in urban research and design as context analysis to determine relative importance of specific spatial attributes. This way designers can better underpin their design to really fit the local context. It can potentially be developed as a method useable in other spatial contexts as well, where perhaps the finetuning of the attributes is required, but the core of the method remains the same.
This graduation thesis responds to the uncertainty between the theory and practice as it attempts to first test the prior findings in a specific context, and second to translate the findings into recommendations for spatial interventions.

02 | Methodology

2.1 Research Questions

The following main research question is derived from the problem field and statement in the previous chapter, and indicates the core topic of this graduation thesis.

How can the public space in Westland, the Netherlands, be adapted to better meet the spatial demands of adolescents for physical activity behaviour?

To find an answer to this question, six sub questions are derived from the main question, which can be divided into three sections: (1) theory; (2) context analysis; and (3) intervention.

| *theory* |

(1) What spatial aspects of the public space are related to adolescent physical activity behaviour?
(2) How can green public space influence physical activity behaviour?

| *context* |

(3) How can choice based conjoint analysis help define important spatial aspects of adolescent physical activity behaviour?
(4) How does the selected public space facilitate or hinder adolescent physical activity behaviour?
(5) What spatial attributes could motivate adolescents to become more physically active in outdoor public space?

| *intervention* |

(6) How can a specific public space in Westland be adapted conform the research findings to better accommodate adolescent physical activity behaviour?

2.2 Research Objectives

Explore (1) What spatial aspects would contribute to increase physical activity levels of adolescents; (2) How choice based conjoint analysis can be used in urban research and design to investigate user preferences of adolescents for physical activity in public space. And (3) How public space in Westland can be transformed with use of the results of the conjoint experiment to to create active friendly public spaces fit for adolescents.

Translate theoretical knowledge and knowledge from (prior) empirical research into a research method to test in this spatial context. And use the results to develop practical recommendations which are tailor made for a specific test case in Westland.

Stand up for the importance of paying attention to the design of the urban fabric as contributor to coping with public health issues using methods and knowledge from other disciplines when necessary. Showing what can be done to develop a public space that facilitates adolescent physical activity behaviour as good as possible.

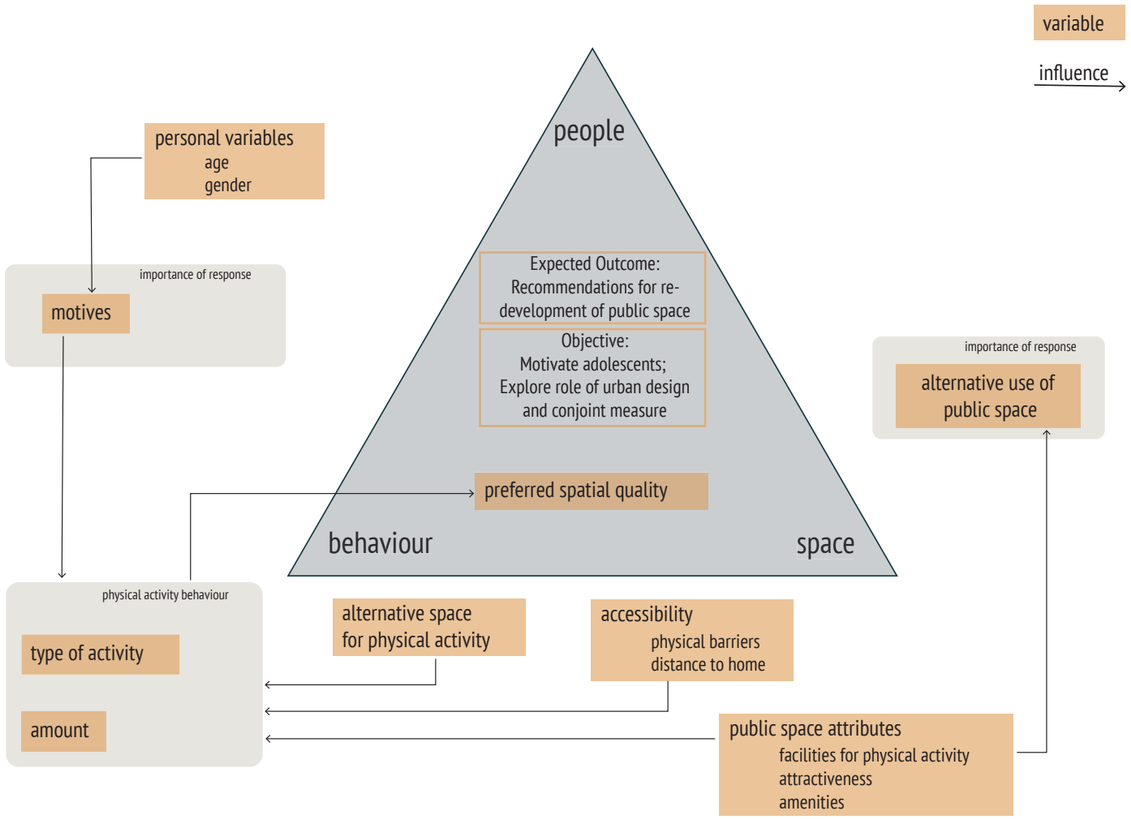


Figure 8 | Conceptual Framework with used variables and relations

2.3 Conceptual Framework

Figure 8 shows a model to visualise the the different types of influences on physical activity behaviour in public space. As stated before, three components are influencing each other: (1) people (2) behaviour, and (3) space. To be able to intervene at the crossroad of the three key components, is to understand how each component influences the other (two). They can be defined separately, but all three components are always present. Behaviour cannot be interpreted without understanding the people showing that particular behaviour. Different target groups might have different motives for physical activity, and may desire different types of activities. The same applies for the personal variables. Age is not just how old a person is, but is also related to how active this person is. Bauman et al. (2012) e.g. show several studies where results show that the older children get, the less active they become. The personal variables, reasons for physical activity, and alternatives for time to spend influence the amount one is active and the type of activity (e.g. Bauman et al., 2012).
The amount and specifically the type of physical activity determine the spatial demands for a specific space. Walking requests other spatial attributes than playing soccer. Therefore it is necessary to understand how adolescents behave and in what types of activities they engage.

The spatial attributes ‘accessibility’ and ‘public space attributes’ in Figure 8 at their turn facilitate or hinder specific types of behaviour. When the access to a playing field is easy and safe, it is more likely people use the facility, then when they need to cross high speed roads and all sorts of gates.
To facilitate adolescent physical activity will probably ask for specific spatial attributes of public space. The composition of attributes can be more suited for non-active types of activities, such as relaxing and meeting other people. This alternative use of public space is used in the survey to understand what kind of activities adolescents undertake in public space, and thus to what extent public space is important as location for physical activity. The same counts for alternative spaces for physical activity. They both are outside the scope of the transformation of space.

Not all variables in this conceptual framework are among the influence of an urban designer, like age and gender. These are however necessary to understand the behaviour of this specific target group and are used to describe the sample. Analysing the variables in various ways will lead to an understanding of the spatial demands for adolescent physical activity behaviour. These spatial demands will act as the basis for the recommendations to adapt the typology of public space in Westland.

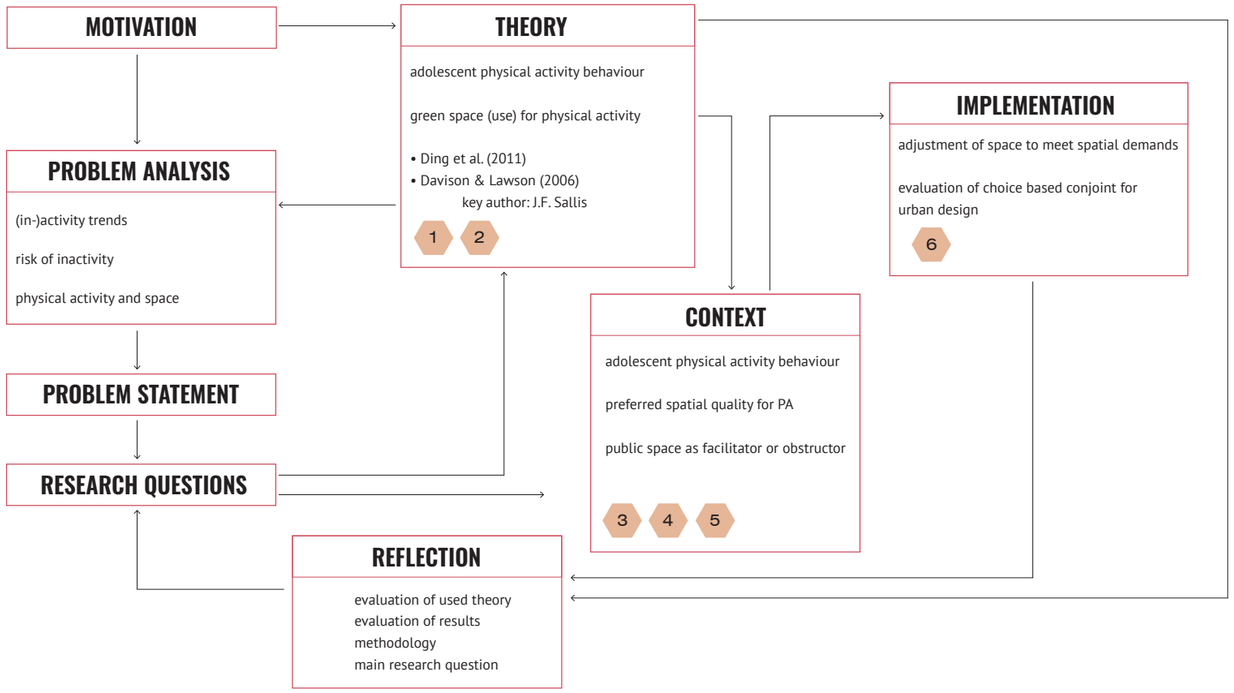


Figure 9 | Methodological Framework

accessibility	proximity physical barriers suitable infrastructure for slow traffic
spatial structure	size of green public space facilities (sports fields, trails) amenities (seating, toilets) attractiveness (water, vegetation, animal life)
individuals' characteristics	personal variables (age, gender) motivation and barriers physical activity preferences

Figure 10 | Adolescent physical activity attributes

Reviewed and determined by author; based on Bauman et al., 2012; Davison & Lawson, 2006; Ding, Sallis, Kerr, Lee, & Rosenberg, 2011; Hartig, Mitchell, de Vries, & Frumkin, 2014; Lee & Maheswaran, 2011; McCormack, Rock, Toohey, & Hignell, 2010; Sallis, Prochaska, & Taylor, 2000.

2.4 Methodological Framework

RELATIONS WITHIN METHODOLOGICAL FRAMEWORK

Roughly three phases can be distinguished in this graduation thesis: (1) Theory, (2) Analysis of context, and (3) Intervention. Figure 9 and 11 respectively show these phases related to each other, and the approach to answer each sub question separately.

Within the theory phase prior empirical research on adolescent physical activity behaviour in relation to the physical environment is reviewed. The theory paper addresses the use of geen space in relation to physical activity in general. From these two viewpoints (spatial) attributes are defined to use in a digital survey and analysis and design of space. Not all attributes that have been found were relevant to this specific context or adaptable by urban design.

The digital survey is developed to understand the spatial demands of adolescents for physical activity in public space and to research several other variables influencing physical activity behaviour. In this survey, design is used as a research tool to develop sixteen alternatives of public space to use in the choice based conjoint analysis. This method can inform a designer on the spatial demands of adolescents for physical activity in public space. With the design, the selected spatial attributes are visualised in such a way that they can be compared by the adolescents to find out their preferences. A more in-depth explanation of this method can be found on the following pages.

The results of the conjoint experiment are analysed using Multinomial Logit Regression Analysis (MNL). With this analysis the relative importance of the ten spatial attributes is examined. The results are used to research and assess an existing public space as a test case. Based on the presence and composition of the ten attributes in the test case the fitness for adolescent physical activity is determined. From that point, design is used again to illustrate how the test case could be adapted in such a way that it best facilitates adolescent physical activity behaviour.

RESEARCH TOOLS

LITERATURE REVIEW

Both academic and grey literature are used to elaborate on two theoretical perspectives: (1) green space use for physical activity and (2) adolescent physical activity behaviour. These studies are used to identify variables influencing adolescent physical activity behaviour to use in this thesis. Ten spatial attributes are selected from this review to use in the survey. An overview of all found correlates can be found in Appendix A-3.

It also includes reviewing data and grey literature on (Dutch) physical activity behaviour and trends, using sources as Statistics Netherlands (CBS). Furthermore the international situation, and benefits of physical activity is researched using information from e.g. the World Health Organization.

refers to sub questions 1 and 2, and is used as input for sub questions 4 and 5, and 6 indirectly

SPATIAL ANALYSIS

Spatial analysis is done through mapping and drawing. Before selecting a test case to transform, the public space was inventoried using a typological framework, based on data from the municipality of

Westland. With the preliminary survey results a specific square was selected to transform. This square is analysed conform the ten spatial attributes using mapping and photographs.
refers to sub questions 4 and 5, and is used as input for sub question

SAMPLE SURVEY

Active involvement of the adolescents is an essential component in this graduation thesis. Therefore a digital sample survey is developed with use of the software Qualtrics. Questions are within five themes: (1) general information; (2) physical activity behaviour; (3) motivation and barriers for physical activity; (4) the use of public spaces; and (5) preferred spatial quality for physical activity in public space. Answer types for the question on the location of physical activity are developed based on the Vrijetijdsomnibus 2012-2017 used in the 'Rapportage Sport 2018' (SCP as cited in Sociaal en Cultureel Planbureau & Mulier Instituut, 2018, p.246). The answers on the questions regarding barriers for physical activity are based on a web article on motivation and barriers, and again the 'Rapportage Sport 2018' (Sociaal en Cultureel Planbureau & Mulier Instituut, 2018; Visser, Duijf, & van den Dool, 2019).
The entire survey can be found in Appendix A-7.

From the survey results, a profile of the respondents and their physical activity behaviour is made using the reports function in Qualtrics and Excel. The core of the survey consists of a choice based conjoint experiment on the preferred spatial quality of public space for adolescents to engage in physical activity. This part is used to extract important spatial characteristics to use later in the design. Choice based conjoint analysis can be used to estimate user preferences for different products or services when letting them choose for their preferred one in sets of alternatives (Boumeester et al., 2008). Each respondent will be asked five times to choose between two profiles in which they would prefer to be active in. Each question has a third answer option: 'none of the above'. Each profile is composed out of the ten spatial attributes retrieved from the literature review. For each spatial attribute two levels are defined, mainly referring to the presence or absence of said attributes. These attribute levels would lead to a total of 2^{10} = 1,024 possible combinations of ten attribute levels, resulting in over 1,000 different profiles to assess. This is called the full-factorial design (Boumeester et al., 2008). To not overstimulate respondents and still have a useful survey, only sixteen profiles are developed using Basic Plan number 3 by Addelman as used in Steenkamp (1962a as cited in Steenkamp, 1985, p.147).
This makes a fractional factorial design, where only main effects can be estimated (Boumeester et al., 2008). The Basic Plan and development of the alternatives can be found in Appendix A-5.
Before these questions respondents are shown an example to explain where they have to pay attention to. To validate the given results, a sample of approximately 200 respondents was sought. Respondents were approached in different ways: (1) via the Youth Counsil of the municipality of Westland, through e-mail, whatsapp and Instagram, and they were asked to spread it within their network; (2) through the Facebook pages of 'Jan Westland' and its subpages on each village of Westland; from the social organisation 'Vitis Welzijn'; (3) through the network of the youth workers based in Westland; (4) through my handball association. Because these kids are bound by the subject of this thesis (physical activity), they have been asked to spread the survey in their class or network, but not fill it in themselves to prevent a distorted image of the results. When this still appeared to result in too little responses, (5) in a final attempt staff members of the Faculty of Architecture were approached to let their children, if any within this age group, fill in the survey. In the end this has resulted in 135 responses, of which 65 were useful. Unuseful responses were either not finished, the respondent fell outside the target group (too old, too young) or they had not given their consent. It is acknowledged that the way of distribution has not led to an optimal representative sample of the target group.

Before distributing the survey, it was tested first among a pilot group of eight adolescents. With their feedback the questions and profiles are adapted to distribute among the definitive target group.

An ethics application is handed in to and approved by the Human Resources Ethics Committee of Delft University of Technology. This to ensure safe and secure use and storage of the data, and to ensure a just use of the survey considering the target group of minors. This application contains information on the informed consent, the use and storage of the data, and the respondents and has been made with advise from both the privacy consultant and the data steward of the Faculty of Architecture. The letter of approval can be found in Appendix A-4.
refers to sub questions 3 and 6

STATISTICAL ANALYSIS OF SURVEY RESULTS

The core of the survey, the choice based conjoint questions on preferred spatial quality for outdoor physical activity is analysed using a no-choice multinomial logit regression in Biogeme (Boumeester, 2008). Biogeme is an open source software package that makes use of Python, specifically developed to estimate parameters in choice models (Bierlaire, 2020, p.1). The version PandasBiogeme 3.2.6 is used.

With this statistical analysis, the relative importance of each attribute level as compared to the other attribute levels can be estimated. Each choice set of profiles counts as one observation, resulting in five observations per respondent. This has lead to 309 observations for the analysis. The analysis is done for the entire group of respondents. With the same data the analysis is done four more times for for boys and girls separately, and for children younger than 16 and 16 and older.
This analysis shows which attributes of public space are more important to adolescent physical activity behaviour than others and is used to assess the selected public space in Westland on its fitness for adolescent physical activity. The survey results are also used to inform the redevelopment of this specific public space in Westland.
refers to sub questions 3 and 5, and is used as input for sub question 6

SITE VISIT

To observe and document current conditions of the spatial structure of public space in Westland, site visits. Experiencing the location, photography is used as tool to document current conditions.

mainly refers to general uderstanding and analysis of the spatial context, and sub question 4 and 5, and is used as input for sub question 6

URBAN DESIGN

The design of urban form is used in two phases of the graduation thesis. First, it is used as a research tool in the survey. Through research by design a composition of the sixteen profiles with spatial attributes is made using eye level perspectives. In the final stage of the thesis research by design is used to illustrate the survey and analysis results. The results of the MNL analysis and of the other survey questions are used to adapt a specific case in Westland. This illustrates how a public space can be transformed conform the research done. With use of eye level perspectives, plans and sections, the recommendations are illustrated to communicate the changes.
refers to sub question 6

How can the public space in Westland, the Netherlands, be adapted to better meet the spatial demands of adolescents for physical activity behaviour?

	sub question	objective		method	outcome
THEORY	(1) What spatial aspects of the public space are related to adolescent physical activity behaviour? (2) How can green public space influence physical activity behaviour?	(1) identify spatial dimension of physical activity behaviour (2) develop understanding of complexity of physical activity behaviour inform survey, spatial analysis, and design recommendations		literature review on (1) adolescent physical activity behaviour and (2) environmental correlates of adolescent physical activity behaviour	(1) adapted ecological model explaining variables influencing adolescent physical activity behaviour and (2) collection of spatial aspects to analyse and design with
CONTEXT	(3) How can choice based conjoint analysis help define important spatial aspects of adolescent physical activity behaviour?	to epxlore if choice based conjoint analysis can be used and how it can be implemented in urban design	 	digital survey among adolescents	concluding remarks on use of choice based conjoint analysis in urban research and design
	(4) How does the selected public space facilitate or hinder adolescent physical activity behaviour?	assess selected space		spatial analysis of spatial attributes defined in sub questions 1 and 2 using maps and photographs	collection of maps, drawings, and photographs for a variety of types of public space, showing the current state and its fitness for adolescent physical activity behaviour
	(5) What spatial attributes could motivate adolescents to become more physically active in outdoor public space?	identify specific spatial aspects important in this context	 	survey on spatial demands to use public space to be physically active, using research by design; informed by sub question 2	conclusion on relative importance of spatial attributes for adolescent physical activity behaviour
INTERVENTION	(6) How can a specific public space in Westland be adapted conform the research findings to better accommodate adolescent physical activity behaviour?	visualise and communicate possibilities to intervene in public space		research by design, informed by user preferences and prior studies	transformation of existing public space and derived general recommendations

Figure 11 | Sub Questions and their respective methodology

2.6 Research Limitations

The research limitations form the boundaries of the graduation thesis. This graduation thesis does not pose a one-size-fits-all solution to the inactivity threat. Changing behaviour is very complex having many more variables influencing it than just the physical environment (Sallis et al., 2006). A large amount of the variables are out of the influence of urban design. Some of the variables that are within the reach of urban design, are used and adapted, but to effectively diminish physical inactivity it is necessary to work through all scales and disciplines together on solutions.

A few remarks can be made to the use of public space for physical activity. First, physical activity can be undertaken in alternative environments than the public space as it is used in this thesis. To create a complete picture this is asked for in the survey, but the focus on the analysis and transformation of space is on public spaces such as squares, parks and other areas. The qualities of the network of public spaces is outside the scope of this thesis. To increase impact, non-green public spaces are included. To find out if green space plays a role in activity behaviour, this was part of the theoretical framework.
Second, alternative uses and alternative users can request different spatial facilities or a different composition of the public space. This asks for carefully balancing all interests in real life. For this thesis, the scope is specifically on adolescents and physical activity.

Due to the initial response ratio the connection with Westland in the survey had to let go of to retrieve enough responses. Because adolescents living in Westland still are less active than the Dutch average, and very little green space, Westland remained the location for the redevelopment of public space. It is assumed that Dutch adolescents do not differ too much from Westland adolescents, so that the survey results will be applicable in this spatial context. The transformation of a specific type that can be found elsewhere and is not too much context specific helps overcome this too. The transferability of the project results will also be discussed in the reflection in chapter 6.

A large amount of the empirical studies included in the used reviews are from North America, and some from Australia. The review of Ding et al. (2011) includes only 18 of 103 European studies. No European reviews have been found yet, there might thus be differences in influencing correlates. However, because of the similarities in country types (high-income, Western) these reviews are used anyway. The testing of the correlates in the survey will contribute to the evaluation of the used reviews in this spatial context. Because of the subject of the theory paper - green space use in relation to physical activity behaviour in general - some of the used spatial attributes are not explicitly associated with *adolescent* physical activity behaviour. As the theory subject was selected before the target group this was unavoidable. In the reflection in chapter 8 there will also be reflected upon these attributes and the extent to what they do or do not influence adolescent physical activity behaviour.

2.7 Ethical Considerations

Active involvement of adolescents

WIth the active involvement of adolescents it is important to handle their input with care. They should feel safe and comfortable to answer the surveys honestly, for me to get the most reliable results. The only personal information the respondents had to give is their age and gender, age also to check if they fit within the target group. It is explained in the survey that it is not about their personal information, but that it is only informative to draw conclusions on spatial design for physical activity behaviour and with thus is helpful for this graduation thesis.
The results shown in this report are anonimysed further, not risking identification of individual respondents. The results that needed to be uploaded to the 4TU.Centre for Research Data show single observations together with the answers to the other questions, if respondents gave consent for that. Informed consent from the adolescents themselves or from their parents is asked for before filling in the surveys on several aspects of the process, and is stored separately. After the graduation, the survey data will be deleted from Qualtrics to ensure no further distribution of the data.

The ethics application is made with advise of the data steward of the Faculty of Architecture and the privacy consultant. It covers informed consent, data storage and software use. The application is approved by the Human Resources Ethics Committee of the University.

Differences in interpretation

Apart from privacy issues, it is important to acknowledge and understand the possibilities of misunderstanding. Developing clear and specific questions without too many subjective terms will minimise the risk at misinterpretation at one of both ends. This is accomplished by clearly explaining all definitions and terms used, and by defining the questions as unambiguous as possible. The survey has been tested among a group of eight adolescents to filter out further ambiguity and uncertainties.

Personal networks

Because of my origin I have several personal networks within Westland. One of these is through my handball association where I have been playing since I was a little girl and where I have been volunteering the past three years, currently as trainer/coach. The subject of my graduation thesis is overlapping the reason this network exists (being physically active). I have tried my best to find respondents for the survey outside of this network. Unfortunately due to the response rate I did use this network to further distribute my survey. To not get distorted results, I have asked the kids to *not* fill in the survey themselves, but only distribute it to their class, friends, or family.
The sampling of the respondents is therefore not by the book. In order to get enough responses to draw relevant conclusions, this was at this point in time the only way.

Play area in Wateringen (2020).

In this part the theoretical background of the graduation thesis is presented. Two perspectives on physical activity behaviour as related to the physical environment have been used.
(1) It is seen from the behavioural side: it is explored what variables influence adolescents to be physically active or not.
(2) The topic is explored through the use of green spaces for physical activity. This second part is the assignment for AR3U023 Theories of Urban Planning and Design, and is adapted somewhat to fit in the report. Chapter four displays the translation of the theory findings into the imageing of public space for the survey.

PART 02 | THEORY

demographic and biological variables	gender (male)	+
	ethnicity (European American)	+
	age	-
psychological, cognitive, and emotional variables	achievement and orientation	+
	perceived competence	+
	intention	+
	perceived physical appearance	?
	self efficacy	?
	attitude & outcome expectation	?
	likes physical education	?
	benefits of physical activity	?
	depression	-
behavioural attributes and skills	sensation seeking	+
	previous physical activity	+
	community sports	+
	cigarette use	?
	meal regularity	?
	sedentary after school	-
	sedentary during weekend	-
social and cultural variables	sibling physical activity	+
	direct parental help in PA	+
	parental support	+
	support from significant others	+
	support from peers	?
	subjective norms & social influence	?
physical environment variables	opportunities to exercise	+

Figure 12 | Variables related to adolescent physical activity behaviour, as summarised by Sallis et al (2000) in a review study of 108 studies.
+ is positively related, ? = inconsistent results, and - = inversely related

3.1 Adolescent physical activity behaviour

A large variety of variables influencing adolescent physical activity behaviour makes it complex to understand and to intervene in. Three review studies are used to understand the different types of variables. The variables referred to in these studies are shown in the Figures 12 to 14. Only those variables that either have shown a positive or inverse association with adolescent physical activity behaviour, or those with inconsistent associations are shown for the scope of the thesis. Variables that showed no association are left out. The main focus is on those variables concerning the physical environment. For clarity and completeness other variables from the three reviews are shown in the Figures as well.

In a review of 108 studies, Sallis et al. (2000) show variables concerning the personal, and the physical environment of adolescents. They distinguish five categories of variables, as is shown in Figure 12. First, demographic and biological variables appear to have either a positive or inverse relationship with physical activity behaviour. Age is inversely related, meaning that the older the children get, the less active they are. Second, the psychological, cognitive, and emotional variables are stated. Remarkable is that associations between these variables and physical activity behaviour are less consistent than other categories. Possibly they are more difficult to measure as they are so subjective. Third is a set of variables related to human behaviour and include a variety of variables. Obviously sedentary behaviour is negatively associated with current physical activity levels. What is noteworthy is that previous physical activity levels are positively associated with current levels, as already mentioned in chapter 1. Current activity levels could thus indicate how active adolescents will be in the future.
Fourth, the social and cultural variables mainly refer to the social environment adolescents are part of. Support from different people in their close social circle appear to be predominantly positively associated with their physical activity behaviour. Finally, Sallis et al. (2000) have found one variable of the physical environment in their reserach: opportunities for adolescents to engage in sports or exercise. This is positively associated with adolescent physical activity behaviour. Possibly because of two reasons. One, people always need some kind of space to engage in physical activity, even if it is just a path. Things that are absent, cannot be used to be active. And two, the higher the variety in opportunities for physical activity is, the more it is fit for a larger group of different people, also resulting in higher individual levels of physical activity.

The two other review studies used in this graduation thesis mainly focused on the physical environment itself. The first one is done by Ding et al. (2011). The findings

social and cultural variables	incivilities / disorders	?
physical environment variables	land-use mix / destinations	+
	residential density	+
	parks	?
	recreational facilities	?
	street connectivity	?
	walking and cycling facilities	?
	traffic speed and volume	?
	traffic safety	?

Figure 13 | Variables related to adolescent physical activity behaviour, according to a review of 103 studies done by Ding. et al (2011).
+ is positively related, ? = inconsistent results, and - = inversely related

social and cultural variables	social disorders	-
	unsuitable weather	-
physical environment variables	access to destinations	+
	proximity to parks and playgrounds	+
	recreational facilities	+
	neighbourhood aesthetics	+
	street connectivity	?
	urbanity	?
	(traffic) safety	?/-
	physical disorders	-
	distance to school	-
	presence of bike lanes	-

Figure 14 | Variables associated with adolescent physical activity behaviour, according to a review of 33 studies, done by Davison & Lawson (2006).
+ is positively related, ? = inconsistent results, and - = inversely related

from this review are visualised in a similar way in Figure 13 as those from Sallis et al. (2000). The second one is from Davison & Lawson (2006), and those variables are visualised in Figure 14. All variables together are included in Appendix A-3.

Variables in the study by Ding et al. (2011) are divided into four categories: objective or perceived environmental variables, combined with reported or measured physical activity levels. Variables that showed inconsistent or positive/inverse associations with *reported* adolescent physical activity are included.

Both Ding et al. (2011) and Davison & Lawson (2006) have used a different categorisation from Sallis et al. (2000). For the understanding and the possibility to compare, the variables from the used reviews are by the author classified conform the categorisation of Sallis et al. (2000). A differentiation of the physical environment variables is made later in the thesis.

Notable is that Ding et al. (2011) are overall less conclusive on the association with physical activity behaviour than Davison & Lawson (2006). This might be because of the reviewed number of studies: where Ding et al. (2011) have reviewed 103 studies, Davison & Lawson (2006) 'only' reviewed 33.

Overall appears that, apart from the inconsistencies, variables that make it easier to use spaces, or that increase the opportunities to use the space are positively associated with adolescent physical activity behaviour. Presence of suitable infrastructure and spatial aspects facilitating active transportation or recreation increase the opportunities for adolescents to be active. Characteristics that hinder the ease of active transportation or recreation, such as greater distances or unsafe situations, are generally associated with lower physical activity behaviour. When e.g. the distance to school is higher, this migh result in the adolescents going to school by other means than active transportation, such as public transport.

3.2 Green space use and physical activity behaviour

3.2.1. Introduction

To prevent physical inactivity from becoming the number one risk factor for deaths in high-income countries, it is essential to develop urban environments that stimulate people to be active. The World Health Organization (WHO) has identified physical inactivity as the number four risk factor[1] for deaths in high-income countries (World Health Organization, 2009, p.10). Inactivity, related to 8% of the deaths, follows (1) tobacco use – 18%, (2) high blood pressure – 17%, and (3) overweight and obesity – 8% (World Health Organization, 2009, p.11). The WHO connect physical activity to both overweight and blood pressure as well, by stating that "energy expenditure" is largely influenced by the level of physical (in-) activity and that an imbalance in energy expenditure relates to being overweight or obese (2009, p.38). This means that people that are physically active are less likely to be overweight than people who are less active, because they use their food to burn energy. Together the three risk factors (high blood pressure, overweight, and physical inactivity) are related to a third of the deaths in high-income countries. Apart from inactivity being a risk factor, participation in physical activity could contribute to lowering risks on both physical and mental health aspects. Diseases such as diabetes (type 2), several types of cancer, cardiovascular disease and depression could benefit from engaging in physical activity (World Health Organization, 2010, p.10). This means that being inactive is not only a risk in itself, but influences other risk factors as well, related to both physical and mental health components. It is thus essential for healthy people to sufficiently engage in physical activity. In order to stimulate people to be physically active, solutions should be sought in all disciplines possible.

In a report on the evidence of the relationship between green space and health, the WHO (2016) has identified physical activity as one of the possible mechanisms explaining the link between the two themes. Several authors relate physical activity to green spaces as they can offer places for specific activities and draw people outside (Hartig et al., 2014, p.214; e.g. Pretty, Griffin, Sellens et al. 2003 as cited in Lee & Maheswaran, 2011, p.213). Figure 16 shows how green space is potentially related to health. It influences health through a so-called mechanism. A mechanism is understood as an intermediary variable, through which green space could be influencing human health. The WHO give several mechanisms among which physical activity (WHO, 2016). Each mechanism is influenced by green space in a certain way, by the opportunities it offers and the characteristics of it. A mechanism then has an impact on specific health aspects, such as different kinds of diseases or moods. In this paper green space is understood as a part of the physical environment with elements of vegetation, and not merely the vegetation itself. It is a space where green elements can be the main motivation for people to visit the space. This can be e.g. a public park with a pond on the scale of a neighbourhood, or a larger nature area like the dunes.

As described in the previous paragraph, and as summarised by Lee and Maheswaran (2011, p.213) from previous studies, there is an agreement on and evidence of the

Figure 15 | Green public space in Wateringen (2020).

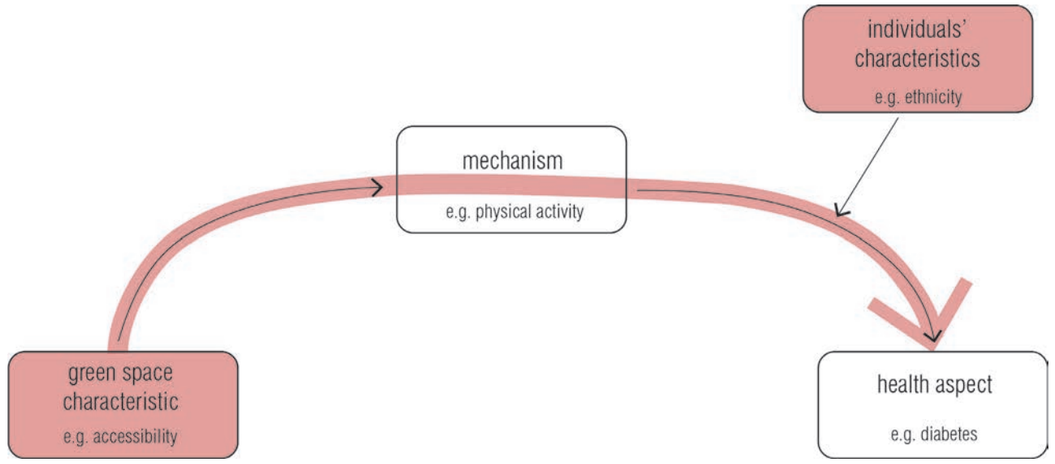


Figure 16 | Relation between the different themes. In red the knowledge gaps as defined by De Vries (2016, p.9).
(Image made by author)

positive relationship between health and physical activity. A causal relationship between (characteristics of) green spaces and physical activity is however more difficult to prove (Lee & Maheswaran, 2011, p.213). De Vries (2016, p.9) argues that this difficulty is one of the possible explanations why the knowledge on the relationship between green space and health is not much being operationalised yet. Other dimension influencing the difficulty of operationalising the relation green space - health in practice as presented by De Vries (2016) are marked in red in Figure 16. These are related to the people using green space and the characteristics of green space itself (2016, p.9). It remains unclear how health is influenced differently by specific green space characteristics (De Vries, 2016 p. 9). Furthermore is still open for question how individuals' characteristics are influencing the impact of green space on health, and if and how the impact varies when individuals' characteristics vary (De Vries, 2016, p.9). Studies done in this field are often difficult to compare because of the high variety in definitions, variables, and methodologies used. Consequently it becomes difficult to use this knowledge in the design of green spaces as it is not specific enough to use in the design of green spaces.

Although these gaps and uncertainties make it difficult to make a clear statement on the causal relationship between green space and health, the mechanisms named before can be used to try to identify characteristics of green space contributing to said mechanisms. The aim of this paper is to find out how urban designers could contribute to improve levels of physical activity through the design of green spaces, considering the given knowledge gaps. To start with, the relationship between green space and physical activity is elaborated on after reviewing empirical studies on this relationship. After that, spatial characteristics that could contribute to stimulating physical activity and the use of green spaces are sought for. The role of the urban designer is made more explicit. When individuals' characteristics are illustrative for the differences in the result of impact they are given. This is however not the main focus of the paper. Finally, conclusions are drawn on what this knowledge could mean for urban designers and how this can be used in the design of public spaces to improve levels of physical activity.

3.2.2. Physical Activity and Green Space

There are different ways to look at physical activity in relation to green spaces. Some studies take a specific activity, e.g. walking, and relate this to several characteristics of the physical environment (Giles-Corti et al., 2005). Others only focus on the amount of green space present in the home environment and link this to participation in several activities (Maas, Verheij, Spreeuwenberg, & Groenewegen, 2008). For this paper the focus is on achieving recommended levels of physical activity, related to several green space characteristics. Other perspectives on green space use and physical activity, or the relation between green space and health can be researched in a similar way.

Results are mixed on achieving recommended levels of physical activity, as are the methodologies to research it. Maas et al. (2008, p.96) did not find people achieving recommended levels for physical activity more frequently when having more green space around their home. As opposed to Maas et al. both Lee and Maheswaran (2011, p.217) and Giles-Corti et al. (2005, p.172) have found that using green spaces increased the probability of reaching these levels. Where Maas et al. (2008) do not take into account the use or opportunities of green spaces, both other studies did, which could explain the difference in results. A possible explanation is that the green spaces in the study done by Maas et al. (2008) are not encouraging use. It appears to be more useful to increase the use of green spaces than to simply increase the amount of green spaces in an urban environment.

Reviewing several studies on people's motivation for the use of green spaces, it becomes clear that physical activity is an motive but often not the main one for people to use green spaces. Where Irvine, Warber, Devine-Wright and Gaston (2013, p.424) found engaging in physical activity to be the most frequently used motive for using green spaces in the Sheffield, UK, several other studies showed that motives related to relaxation and enjoying nature (the weather included) were used more often (Chiesura, 2004, p.132; Cohen & McKenzie, 2007 as cited in: Croucher, Myers, & Bretherton, 2007, p.13; Schipperijn et al., 2009, p.133). Relaxing or enjoying nature does not instantly mean that one is physically active, often these activities are more passive. However, it does ask for people to get to the green space in some way, e.g. by walking there, as also acknowledged by Hartig et al. (2014, p.214). As described in the introduction, Hartig et al. have distinguished two ways in which green space as a part of the physical environment can improve the level of physical activity (2014, p.214). To enable people to use active transportation methods such as walking or cycling to go to a green space, they first need to be motivated to go there. They then should be provided with safe and attractive routes, to enable active transportation to green public spaces. Additionally people should be encouraged to make active use of the green space.

3.2.3. Green Space Characteristics contributing to improving physical activity levels

Following Hartig et al. (2014), green spaces can function as a facilitator to use green spaces in various ways and as attractor to go outside. The facilitation of activities depends on the characteristics of the green public space itself. Green public space as an attractor to go outside is also related to the context of the green public space and how it is embedded in the urban fabric. The characteristics elaborated on below are divided into four categories: accessibility, spatial structure and quality, safety, and individuals' characteristics. It is known that several characteristics overlap or influence each other.

ACCESSIBILITY

The presence of green spaces in a local neighbourhood, and its proximity to one's home are in general positively related to the use of such a green space. For example Cohen, McKenzie, Sehgal et al. have found that "people living within a mile of a park were four times more likely to use it once a week or more" (2007 as cited in Lee & Maheswaran, 2011, p.214). Schipperijn et al. (2009, p.131) conclude from a review of previous studies on the use of (specific types of) green space that green spaces situated more than 300-400 m from one's home are used significantly less than those within 300-400 m. Figure 17 on the right shows results of their own study, connecting the distance from home to the closest green park to the frequency people use this space. This Figure shows that daily visitors often live nearby a park, and that the frequency of use declines when living further away.

In new urban plans green spaces should be incorporated on the scale of a neighbourhood, enabling people to walk there. Consequently an equal distribution of green spaces throughout the entire urban environment is asked for. In restructuring neighbourhoods, it is presumably more difficult to create extra green spaces due to the high pressure on space. Urban designers could implement vegetation and opportunities for use in existing public areas here. Vacant spaces can be transformed into green spaces, e.g. temporary gardens. Extra trees or plants can be added to paved squares or streets. Another possibility is to create multifunctional spaces, combining different functions on top of each other. Figure 18 on the right shows the 'Dakpark' in Rotterdam, where a park has been developed on top of a building with shops.

Powell, Martin and Chowdhury warn that although proximity and distance to home is important, other characteristics might be more important for the use of green spaces, such as (perceived) safety and maintenance

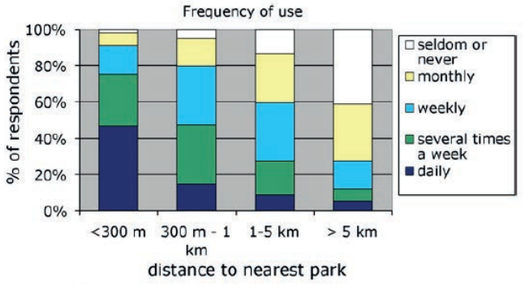


Figure 17 | Frequency of use related to the distance to the nearest park (Schipperijn et al., 2010, p.132).

(2003 as cited in McCormack, Rock, Toohey & Hignell, 2010, p.724). An aspect of safety related to the accessibility of green spaces with an impact on its use is the presence of physical barriers surrounding the green space (Lee & Moudon 2008 as cited in Lee & Maheswaran, 2011, p.217; World Health Organization, 2016). Large infrastructural elements like highways or railways can be difficult to pass for pedestrians or cyclists, hindering them from a safe and easy access. This might discourage people to use a green space or make it for e.g. children less safe to go there on their own. Good accessibility increases the use of green space (Lee & Maheswaran, 2011, p.217). In the urban design an effort should be made to overcome these barriers, by creating safe ways to pass. Safe ways to pass can be created by bridges or tunnels. This enables different traffic flows not to interact with each other. In new plans urban designers can try to place roads more strategically so that they do not separate green spaces from the rest of the neighbourhood. In the rest of the spatial structure surrounding the green space there should be infrastructure available for pedestrians and cyclists, which is according to Heinen, van Wee & Maat more important than the presence of vegetation (2010 as cited in Hartig et al., 2014, p.214). By creating routes specifically for pedestrians or cyclists, it possible to create as little interaction as possible with traffic of higher speed. By connecting green spaces to routing networks and other destinations for people to stay, such as shops, or other public functions, it becomes part of the spatial network. With this, green public spaces are better embedded in the urban fabric of a neigbourhood or city, increasing the ease of access.

SPATIAL STRUCTURE AND QUALITY

When zooming in to the structure of the green space itself, Giles-Corti et al. suggest that it is more important to have larger parks available and accessible, than to have attractive parks nearby one's home (2005, p.172-173). A possible explanation for this finding is that the larger a green space is,

Figure 18 | 'Dakpark' in Rotterdam, the Netherlands, combining park and shops vertically (Brakkee, n.d.).

the higher the variety in opportunities for people to use the space can be. An urban designer can respond to this: by increasing the opportunities for the use of large parks, or developing new places with a high variety of opportunities to use. Vegetation can be used to distinguish the different spaces from one another. Giles-Corti et al. (2005, p.174) have also shown that between Public Open Space (POS) of the same size, the one with more characteristics such as shade, irrigated lawns, water features, and sports facilities attract more people than the one with less of these characteristics. This underlines the need for a variety of opportunities for the use of green spaces. Other facilities that have been found to be influential for the use of green spaces vary between sports grounds and play areas, to trails and amenities such as picnic tables. (McCormack et al., 2010). Some of these facilities or characteristics have an active role for the vegetation itself. Shade can be provided by trees, play areas can have climbing trees or grass to play on, and specific types of vegetation can be used to create natural habitats for specific animals to watch.

In order to attract people, characteristics should be fit for the right user groups. Play facilities meant for children aged 0 to 4 ask for different conditions than play facilities for older children (McCormack et al., 2010). This underlines that before the design, the different user groups and their wishes and demands need to be mapped, to be able to actually design for them. However, there are several features identified to be of importance to all user groups e.g. specific amenities. All people benefit from seating, water features and toilets (McCormack et al., 2010). Elements of vegetation, water nd wildlife[2] are found to be characteristics positively influencing the attractiveness of green spaces (Tinsley, Tinsley & Croskeys, 2002 as cited in Giles-Corti et al., 2005, p.173; McCormack et al., 2010, p.716). These elements can fascinate people to watch (wildlife) and cover city noises with the sound of a water stream or rustling trees (McCormack et al., 2010). Trees can provide shade or protect areas from wind, and urban designers can define the places where this is desirable, e.g. places where people could meet other people. People can also be stimulated to walk a scenic route through the green space instead of a less interesting route or use another mode of transport by the presence of different types of vegetation (Heinen, van Wee & Maat 2010 in: Hartig et al., 2014, p.214).

Continuing on the presence of trees and bushes do Marselle, Irvine and Warber (2013 as cited in World Health Organization, 2016, p.6) suggest that the positive effect of engaging in physical activities in green space, so called 'green exercise'[3], is higher than in other environments. Several studies named by WHO (2016, p.6) have shown exercising in green spaces to be beneficial for mental health.
This is an example of the complexity of the relationship between green space and health. While the impact on physical health, in terms of overweight, might not differ between the two environments (de Vries, van Dillen, Groenewegen, & Spreeuwenberg, 2013, p.27), it is shown that the mental health benefits more from this 'green exercise' than from normal exercise. Several mechanisms related to human health overlap each other, showing the complexity of the relationship and the fact that things can be distinguished from each other, but not be separated.

2 Animal life can also be negatively related to the use of green spaces, as it can scare off children or dogs and so, people who walk their dog there (McCormack et al., 2010, p.716)
3 'Green exercise' has been "defined as physical activity undertaken in green or natural environments" by Barton & Pretty (2010 in: World Health Organization, 2016, p.6).

SAFETY
As expressed in previous paragraphs, (perceived) safety is suggested to be of higher influence than spatial characteristics (Heinen, van Wee & Maat 2010 as cited in Hartig et al., 2014, p.214; McCormack et al., 2010, p.723). Referring to several studies McCormack et al. conclude that fear or the perception of a green space as unsafe discourages use among e.g. children or women (Wilbur, Chandler, Dancy, Choi & Plonczynski, 2002; Kruger & Chawla 2005; Cronan, Shinew, Schneider, Wilhelm Stanis & Chavez, 2008 as cited in McCormack et al., 2010, p.723). According to McCormack et al. safety is mainly associated with the presence or absence of "undesirable users of parks" and public space characteristics such as lighting (2010, p.723). Friction grows when different user groups feel uncomfortable or even scared in each other's presence. Undesirable interactions might be avoided by providing spaces for all types of users and making explicit in the design for whom the space is. This way no user group needs to feel they are not welcome and therefore occupy other people's spaces. Vegetation can be used here to create different spaces. Vegetation itself can influence the perception of safety in green spaces as well. As McCormack et al. continue, clear sight lines and "parks designed to facilitate informal monitoring of behaviour" could help create higher feelings of safety (2010, p.724). Low bushes or trees with only a high canopy can be used to create sight lines which do not block the view and thus make people visible. Placing the green spaces in home environments surrounded by houses that look onto the green space, together with low bushes at the edges of the green space, can enable home owners to monitor behaviour inside the green spaces.

McCormack et al. (2010) suggest that the perception of green space characteristics cannot be separated from the characteristics itself. Thoroughly analysing a location, not only on its spatial structure, but on visitors' perception as well could enable an urban designer to find out why people do or do not feel safe in a specific green space. Closely related to safety and attractiveness, and influencing the perceived safety, is the maintenance of a green space. The condition of the entire green space and the cleanliness of the area play an important role in the use of parks (Lee & Maheswaran, 2011, p.218; McCormack et al., 2010, p.716). Large overgrown trees can make a place feel unsafe, and the presence of litter or dirty places can result in a decrease of the use of such a park (McCormack et al., 2010). Although maintenance is not the responsibility of an urban designer, and does only come in after the design is realised, urban designers could contribute to this by using materials that are sturdy and robust.

INDIVIDUALS' CHARACTERISTICS
Giles-Corti et al. refer to a study done by Tinsley, Tinsley and Croskeys where it is shown that there are differences in the company, frequency of visit, and distance to home among different ethnic groups in the use of green spaces (2002 as cited in Giles-Corti et al., 2005, p.173). The importance of being aware of and understanding

differences in subgroups, based on e.g. age or ethnicity, is underlined by Bell et al. by stating this is “basic research” to do (2007 as cited in Schipperijn et al., 2009, p.131).

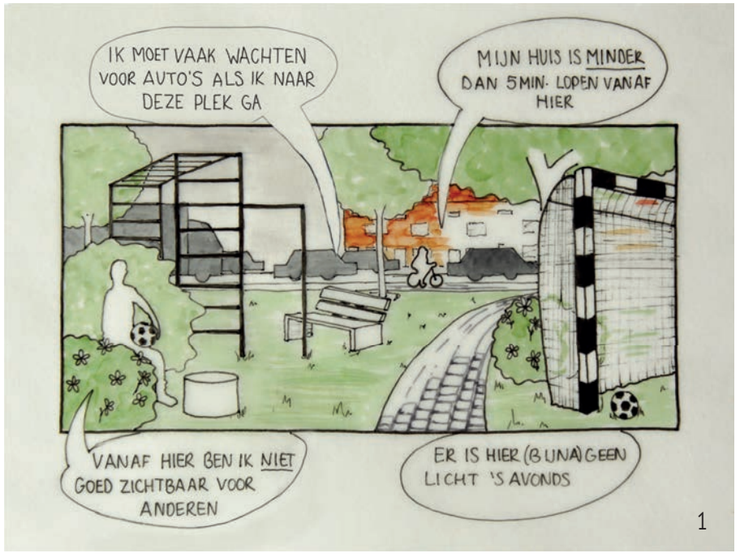
Lee and Maheswaran have reviewed several studies (e.g. Dovey, Reeder & Chalmers, 1998 or Travlou, 2003 as cited in 2011, p.218) that state that individuals’ characteristics such as personal motivation and barriers need to be considered to improve levels of physical activity. If people are not motivated to engage in physical activities or to go outside, the quality and presence of green spaces do not matter. This continues on the complexity of behaviour and the variety of variables influencing adolescent physical activity behaviour as elaborated on in the previous paragraph.
It is essential to understand the demands of (future) users of a specific green space, but personal or cultural differences in e.g. motivation make the role of the urban designer vary too. The greatest result will likely be achieved in areas where people are motivated to engage in physical activity or at least are motivated to improve their level of physical activity and where green spaces are commonly used to be active. In addition to this McCormack et al. mention social environments as important factor to be of influence on “physical activity patterns” (2010, p.723). Cultures that are used to meet outside for e.g. market days or social gatherings might be easier to motivate to engage in more physical activity, than cultures that do not use green spaces that often. The former ones are already inside the green space and using it while the latter ones first need to be persuaded to go outside. A note should be made that climate and weather play a role in this as well. In a cold and rainy climate it is more likely that people meet inside buildings or homes, than in green spaces. In such climates it might be more useful to design e.g. roofed terraces or other places to meet outside, protected from weather influences. Urban designers should design meeting places appropriate for the climate and culture at hand to attract people, then focus on increasing levels of physical activity.

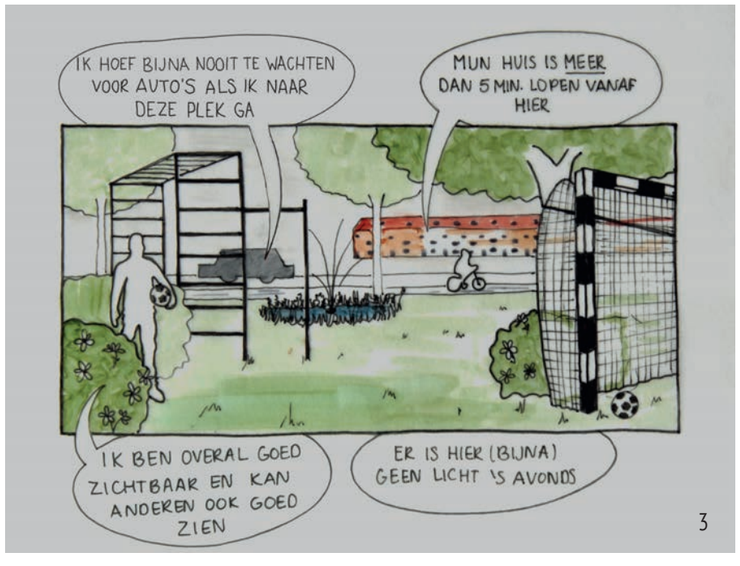
3.2.4. Conclusion and Remarks

BRIEF SUMMARY
In this paper the relationship between specific characteristics of green space and its impact on the level of physical activity is elaborated on. While physical activity is shown to be beneficial for several physical and mental health aspects (World Health Organization, 2009), and is at the same time seen as a possible influencing factor between green space and health (Hartig et al., 2004; World Health Organization, 2016), in practice this relationship is not much being operationalised (De Vries, 2016, p.9). Although results of empirical studies are inconsistent and difficult to compare, it appeared that it is more important to increase the use of green spaces than to simply increase the amount of green spaces to promote physical activity. In order for people to use green spaces, they have to be easily and safely accessible, preferably at walking distance from home, offer a high variety of opportunities for use, and need to be perceived as safe. It is explained that personal and cultural differences as well as the context of the location (e.g. weather circumstances) influence the use of a green space. Before designing anything it is thus important to understand the context and the motives for user, to create designs usable for different user groups.

IMPLICATIONS FOR URBAN DESIGN
Several aspects are to be taken into account for urban designers to design green spaces that encourage people to use them and participate in physical activity. The cultural and social context of a location should be analysed first. An understanding of the motivation of users and other contextual aspects influencing the use of green spaces such as the local climate should be investigated and understood. This enables an urban designer to identify the demands of different target groups using the space. In new urban plans green spaces should be implemented on the scale of the neighbourhood, enabling people to walk there. Restructuring existing spatial structures ask for more creative ways to implement green spaces in the design. Different opportunities for the use of green spaces can be defined. Urban designers can create a variety of spaces within a green space, using elements such as vegetation. Spatial characteristics like presence, proximity, accessibility, and safety of a green space influence the use and should thus be considered in urban design as well. The maintenance of a green space is not within the reach of the urban designer, as this is only relevant after the design has been realised. Urban designers however can think ahead of the maintenance aspects.

From this research it can be concluded that an urban designer has an impact on increasing the use of green spaces, if he or she takes into account all local characteristics of a place. The relationship between green space and physical activity has an essential role for vegetation and green. However from this research it seems to be not just about having vegetation in public spaces, but merely about the design of public spaces in general, where vegetation can be a tool to achieve specific goals.





04 | Spatial Attributes from Theory to Practice

From the two perspectives displayed in the previous chapter, ten spatial attributes are selected and defined to use in the survey and spatial analysis. The attributes can be divided into three categories: (1) the direct surrounding of a public space, including its accessibility, (2) the spatial structure of the public space itself, and (3) the perceived safety.

These ten spatial attributes are used to design the sixteen profiles used in the survey. Each attribute has two levels, and therefore two different visualisations. The attribute levels are combined conform the Basic Plan 3 by Addelman (1962a, as used in Steenkamp, 1985). Beside the sixteen profiles, two extra profiles are composed to use as an example choice set in the survey to explain the task. All 18 profiles are shown in Figure # on the left and following pages.

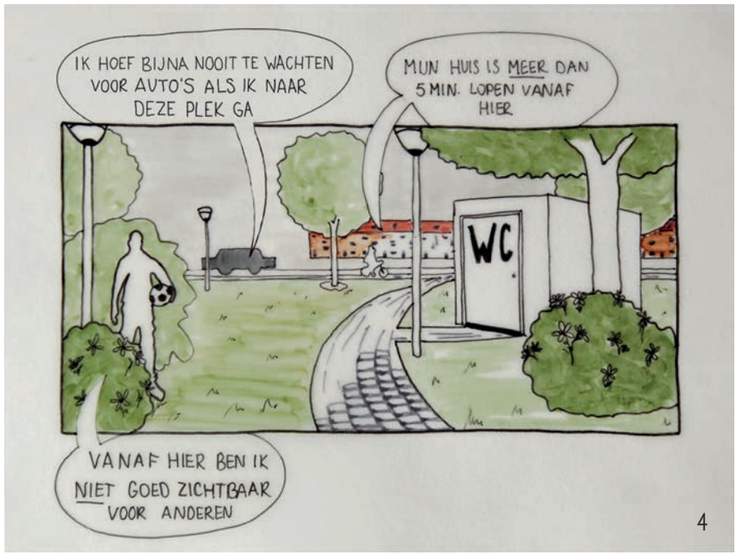
The profiles are drawn as if the viewer is inside the public space and from the eye level of an adolescent (approx. 1.5 meter). For the visualisation a balance is sought between simplicity and understanding. This to limit the amount of information given in a profile, and minimise the chance of overstimulating the target group. Visualisations of e.g. people and cars are kept as basic as possible to not steer respondents to a choice based on their liking or rejection of e.g. a specific brand of car and to reduce complexity. For some attributes a speech bubble is added to avoid ambiguity.

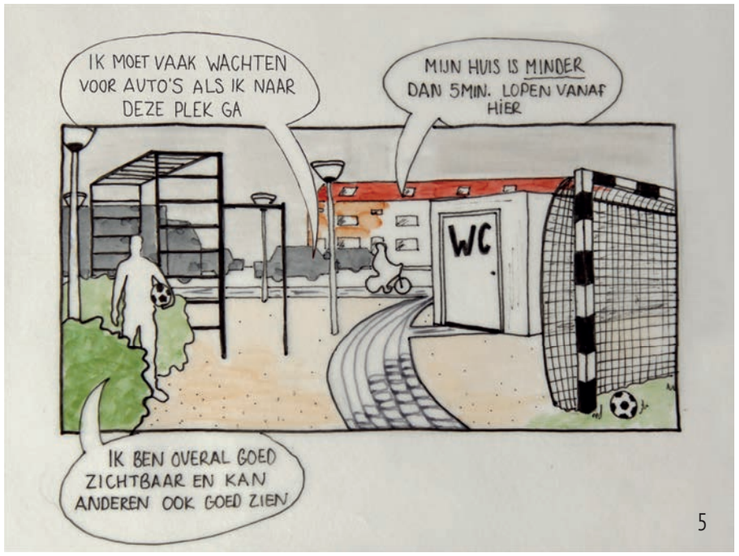
Direct surrounding of the public space

Two attributes are selected considering the direct surroundings of the public space: (1) physical barriers, and (2) proximity to home.

Physical barriers such as high speed traffic lines, bridges that can be opened, or railways around public spaces impose waiting times on adolescents. This relates to both the direct surroundings and the perceived safety of the route. High speed or high volume roads can influence the ease of access of the public spaces and can result in decreased use. Especially for the younger adolescents

Figure 19 | Page 58 to 69: Profiles 1 - 16 for the survey questions, and 17 and 18 as example question



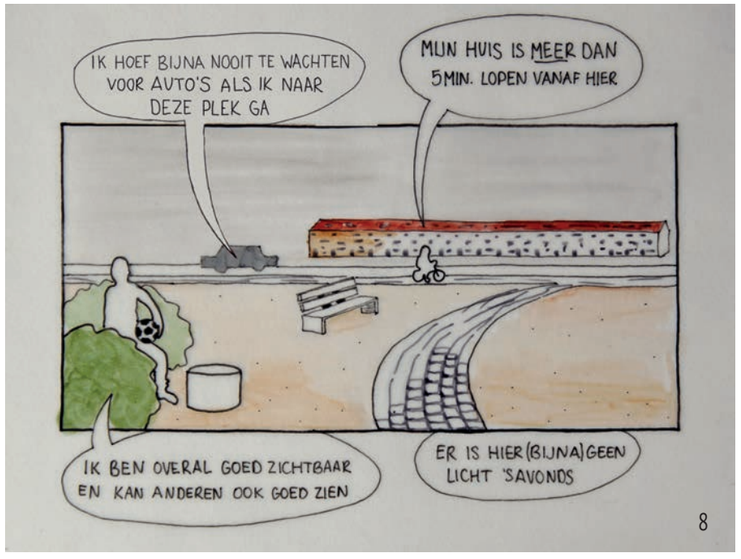


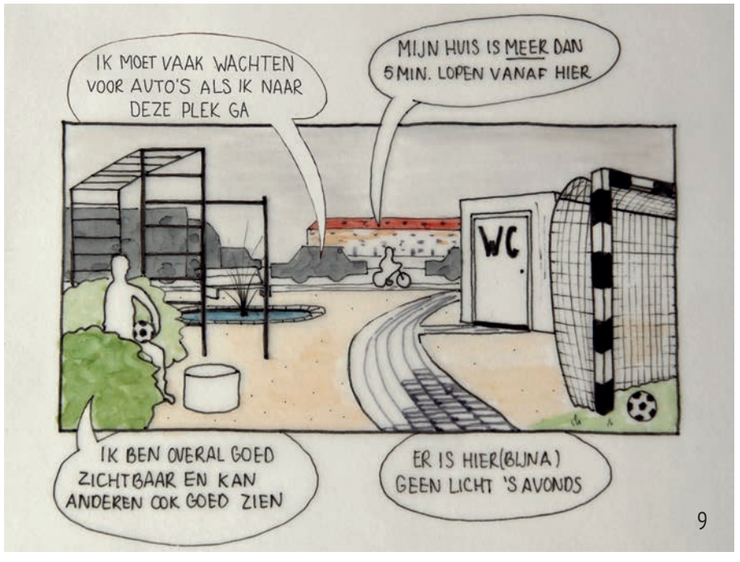
these barriers can have an impact on the frequency of use. In the profiles, a physical barrier is understood as road where adolescents have to wait for to go to the public space. When physical barriers are present, a lot of cars and trucks are shown in the profile visualisation. The absence of a physical barrier means only quiet roads which one can easily pass to go to the public space. In the profile this is shown with only one car. Compare e.g. Figure 19.1 and 19.3. Because of the inconsistencies in understanding of this attribute among the pilot group a speech bubble is added to the profile, showing the key message of this attribute.

Public spaces that are further away take more effort to go. They presumably need to be more attractive and useful to make people take the effort to go there. Another aspect is that people might take other modes of transport to get there, taking away the active transportation opportunities. Considering the distance Schipperijn et al. (2009) use, in the survey the line is drawn at a five minute walk: proximity to the space is either more or less than five minutes walking from home. This attribute is visualised using a row of houses closeby or further away, see e.g. Figure 19.4 and 19.5. A speech bubble is added here for clarity.

Spatial structure of the public space

As suggested in Paragraph 3.2 a higher variety of elements enabling adolescents to engage in physical activity, will lead to public spaces that are fit for more (sub groups of) adolescents. There is a large differentiation in opportunities for physical activity available. It is important that the opportunities are fit for the target group, and thus in the survey a question on the type of activities adolescents engage in, and an open question on their favourite activities to do in public space is added. This can help inform on the specific equipment or space required for adolescent physical activity behaviour.

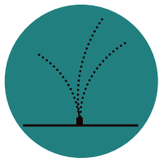




The profiles either show a goal as part of a sports field and some fitness equipment (calisthenics) or none of these, see Figure 19.7 and 19.8. In 2018 soccer and fitness appeared to be the two sports undertaken most among adolescents (CBS & RIVM, 2018).

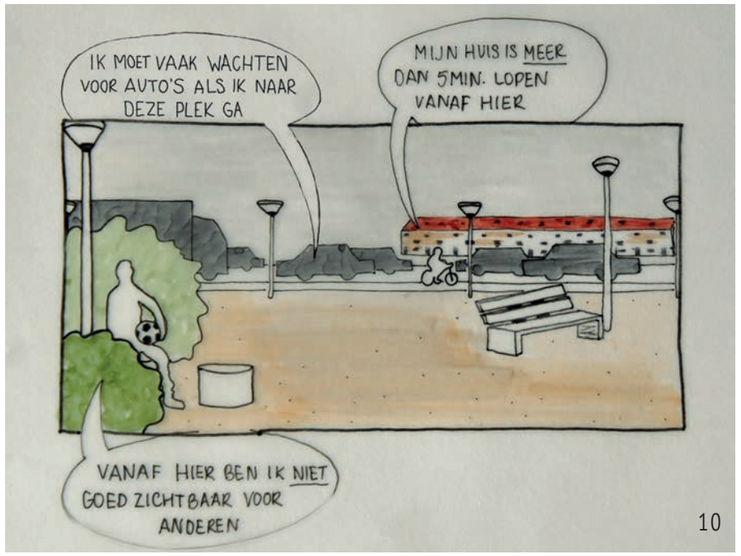
To provide for more different types of activities, cycling and walking paths are included as attribute in the profiles. The differentiation is made between paths throughout the space *and* around the space or just along the edge of the public space. Paths inside can be used either for active transportation (the scenic route to a specific destination) or active recreation.

As shown in paragraph 3.2 the greenness of a space can influence use and physical activity behaviour. According to McCormack et al. (2010) it is an attribute that influences the attractiveness of public spaces. Spaces with a higher appeal may attract more people, increasing the use and with that the probability of physical activity, as well as the perceived safety of the space. In the survey a differentiation is made between little to no vegetation, and only limited variety in species; and a lot of vegetation present with high variety. When a lot of vegetation is present, this is expressed in the profile using a grass field, trees and bushes. Using several green elements also show a variety of uses: trees for shade, or a grass field to play or sit. Little vegetation and variety in greenness is shown as only two bushes to display the presence or absence of secluded areas. See Figure 19.4, 19.8, and 19.9.



Another attribute contributing to the attractiveness of public spaces is water. This can e.g. be a naturally formed pond or a fountain to play in. No difference has been made in the type of water, only the presence or absence is taken into account. The attribute of water is visualised as a small pond, see Figure 19.12.

Two more attributes of green public spaces are included,



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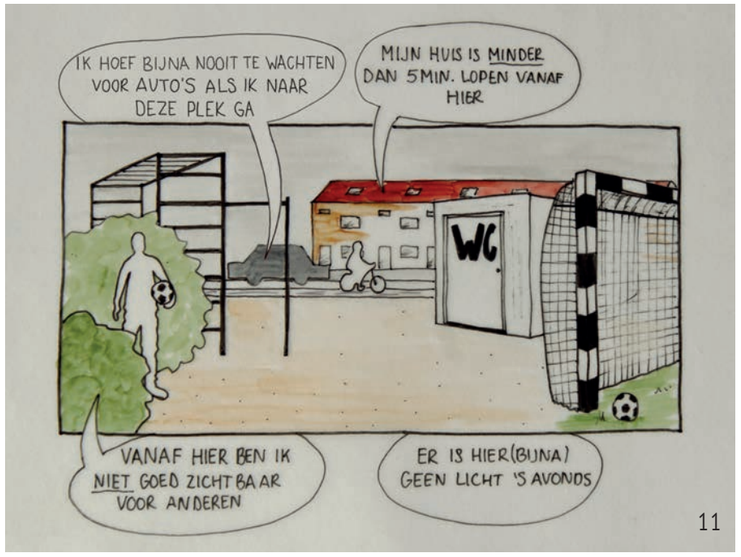

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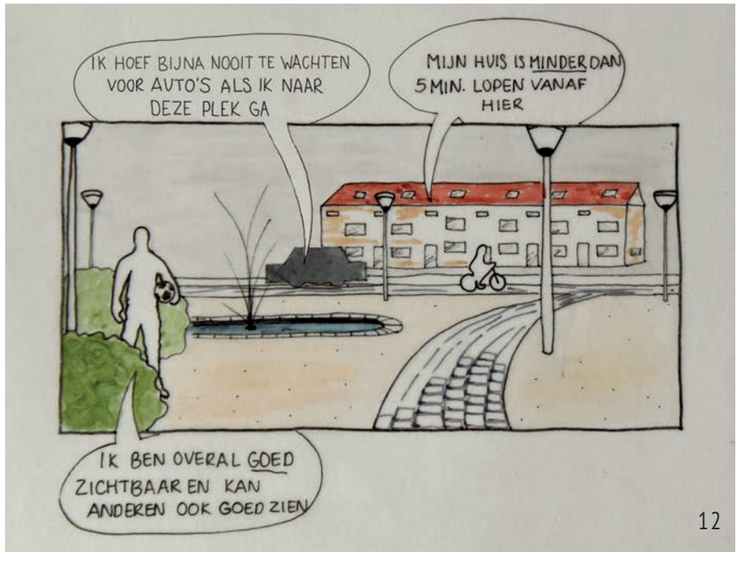

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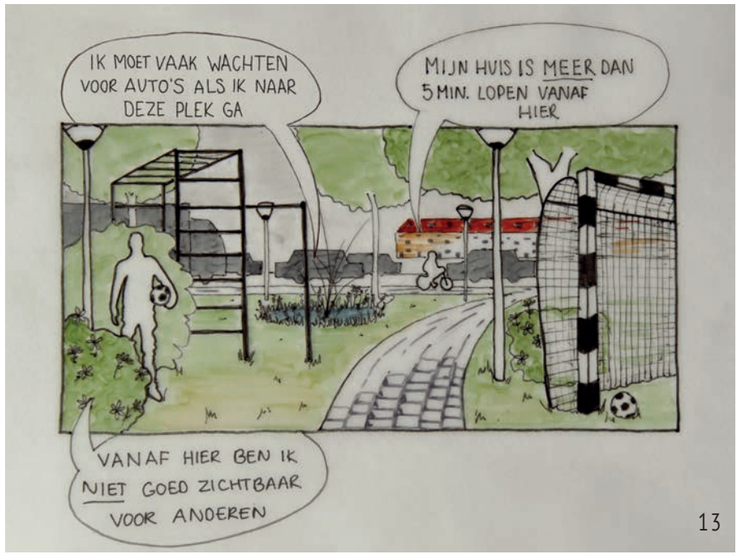
that according to McCormack et al. (2010) are shown to be important for the use of parks for physical activity. The presence of public toilets and seating opportunities enable people to extend their stay. They can rest and use the bathroom when necessary. The water features, seating, and public toilets are all important for the use of parks to all user groups, as stated by McCormack et al. (2010). However, the reviews used in paragraph 3.1 have not shown these type of facilities to be important for adolescent physical activity behaviour. They are used in the profiles for the conjoint experiment, to find out if they are relevant to adolescent physical activity behaviour, or maybe only for the use of green public spaces independent of the type of use. Both toilets and seating can be present or absent in the profiles, and are simply left out when absent.

Safety

Variables concerning the (perceived) safety of space are discussed in almost all of the reviewed literature (e.g. Ding et al., 2011; McCormack et al., 2010). McCormack et al. suggest from their review that "The physical attributes of parks seemed to be inextricable from perceptions of them as either safe or unsafe." (McCormack et al., 2010, p.723). It is interesting to research if indeed safety is a prerequisite in this context for the use of public spaces for physical activity. Several aspects of safety are reviewed in the literature: social safety, mainly concerning present user groups; traffic safety; and physical safety, concerning the maintenance of a space. Two attributes are included in the profiles that can be adapted by urban design.

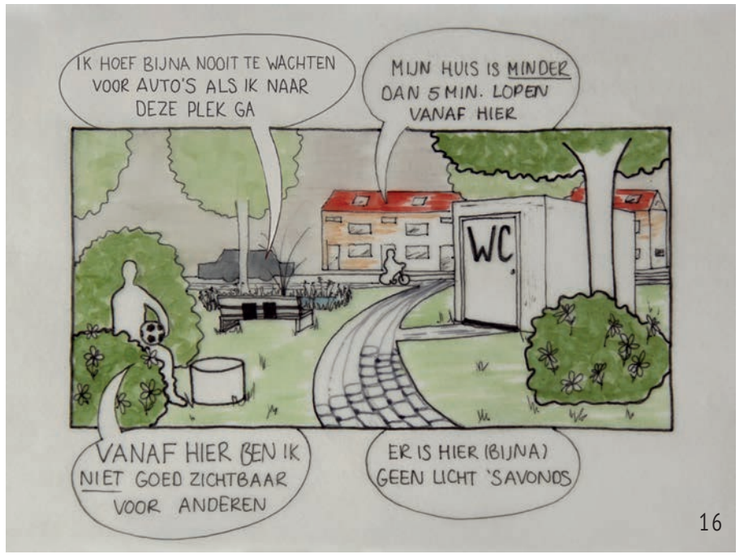
(1) Lighting enables different user groups to see each other, making the way they behave visible for others. It facilitates adolescents furthermore to use public spaces when there is little day light left. Considering the change in school life adolescents have less free time to spare. The presence of lighting increases the functionality of the public space by increasing the time it can be used safely.



In the profiles lighting is either present along paths and facilities or absent, and combined with a speech bubble for clarification.
(2) Secluded paths and areas may influence the perceived safety of a space, as it enables people to behave in a certain way without being seen. This can create a feeling of unsafety, decreasing the use of the space. Possibly this is extra important with younger children, and at night. The key message of this attribute is that people are visible throughout the entire public space or that there are places where people cannot be seen. Overgrown vegetation or no functions around the public space where people can look out ont the space can cause secluded areas. Large vegetation is in the profiles used to visualise that people are not visible everywhere. For clarity a speech bubble is added as well, the differentiation in higher or lower bushes for visibility might be overlooked by respondents.

Some of the attributes influence other ones as well, and specifically safety is often influenced by some other attributes. Vegetation can be a mean to create secluded areas, or can be added in such a way that the entire space is clear. Safety related to traffic volume and speed are indirectly included in the attribute 'presence of physical barriers'.

For all attributes ideas for the use and transformation of public space are given in Appendix A-10.



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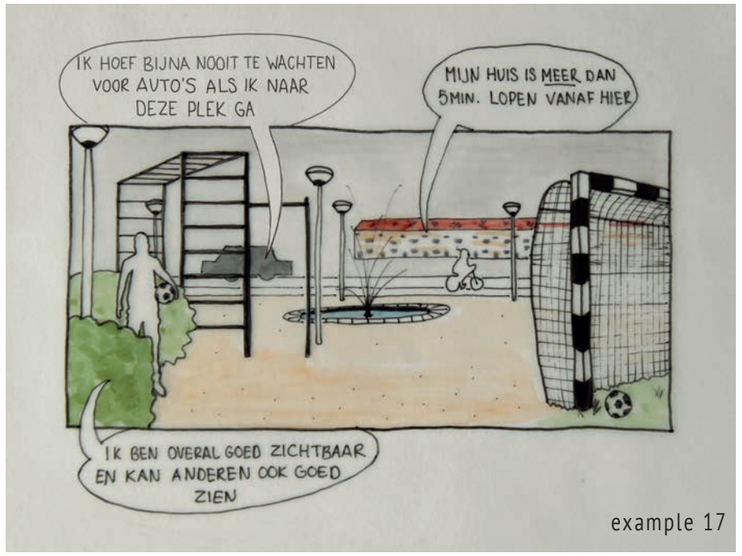
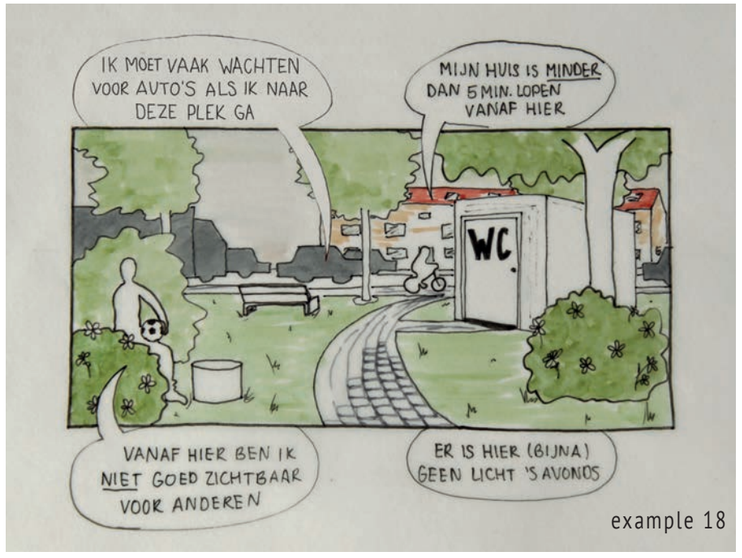


example 17



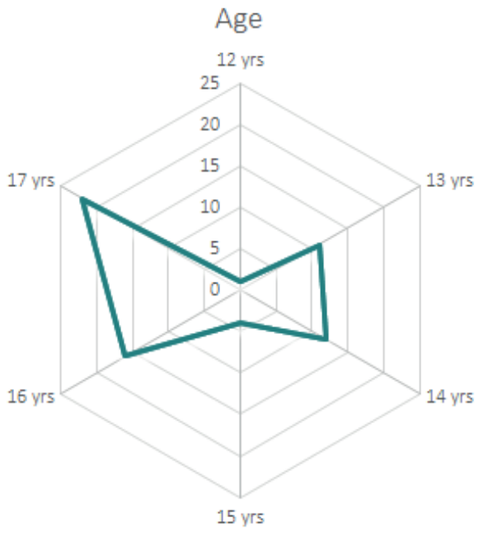
example 18

Wollebrand recreation area in Naaldwijk (2020).

PART
03

This part shows the results of the survey and the implementation of these results in urban design. Chapter five first desribes the sample of survey respondents. The statistical analysis of the choice based conjoint experiment is elaborated on and discussed, together with the results of the other relevant survey questions for the implementation phase. In chapter six then the results of the multinomial logit regression analysis are used to adapt one specific public space in Westland.

| RESULTS



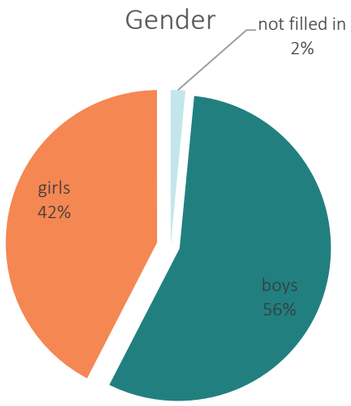


Figure 20 | Survey population

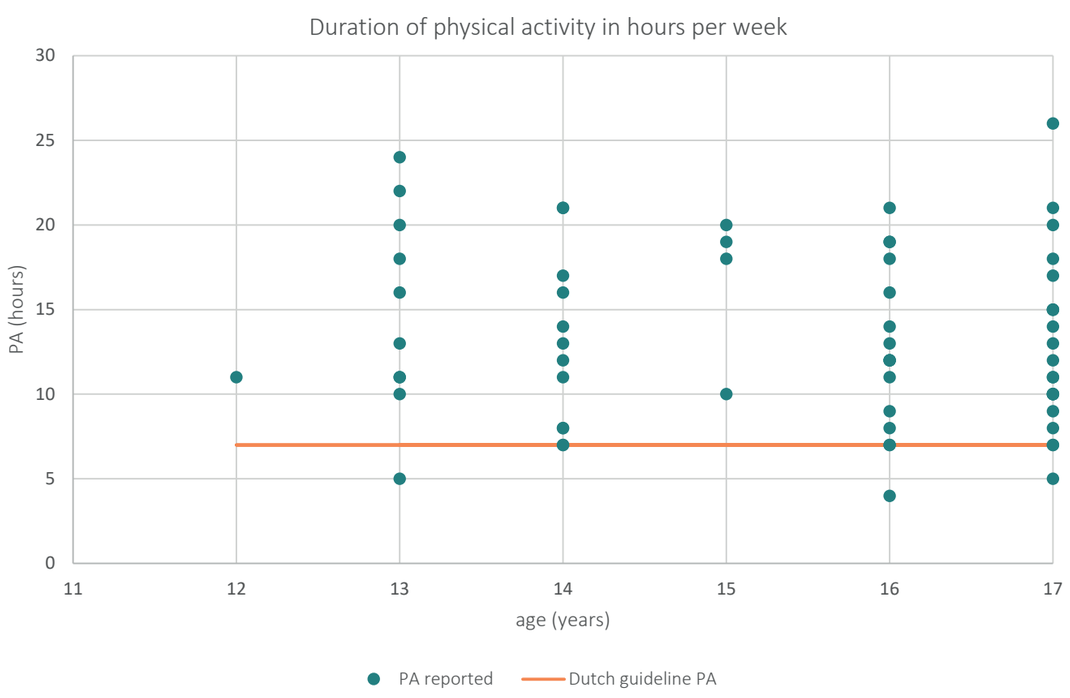


Figure 21 | Average time spent on physical activity per week, based on 65 responses. In orange the advised amount of physical activity per week for adolescents.

05 | Survey Results

As explained before, the survey consists of questions within five themes: (1) general information; (2) physical activity behaviour; (3) motivation and barriers for physical activity; (4) the use of public spaces; and (5) preferred spatial quality for physical activity in public space. The first and second are used to describe the sample. The questions on motivation and barriers, and the use of public space display the value of public space for adolescent physical activity behaviour, and to what extent the public space influences physical activity behaviour. Finally the fifth theme is used as input for the multinomial logit regression analysis to extract the preferences of adolescents for physical activity in outdoor public space.

5.1 Sample Description

The survey has led to a total of 135 responses. When excluding the unfinished responses and those that did not fit the target group (too old, too young, no consent), 65 useful responses remain.
The sample consists of 28 girls, 36 boys, and one without response, see Figure 20. Noteworthy is the dispersion in age: the older adolescents of 16 and 17 years old are well represented, where there are only very few 12- and 15-year-olds. The mean age is just under 15.5 years old.

Figure 21 shows the physical activity behaviour of the respondents in hours per week broken down per age year. As compared to the 'Beweegrichtlijn', which states that every child between 5 and 18 years old should engage in one hour of physical activity per day, the children are all super active: per week they engage in an average of 13.4 hours of physical activity including physical education. Where according to Keetman et al. (2016) only 14% of Westland adolescents aged 12-18 suffice in 2015, and in the Netherlands only 24% in 2016 (CBS & RIVM, 2018), according to the survey results almost 95% suffices. Only three respondents (4.6%) show to be not active enough. However in the physical activity numbers by CBS & RIVM, they have excluded physical education until 2019 (CBS & RIVM, 2018). See as well Figure 2 and 3 in paragraph 1.3. When physical education is excluded, the amount of respondents not meeting physical activity guidelines increases to 11 (16.9%).
Just the inclusion of physical education in the numbers cannot explain the big difference in activity numbers between the Dutch numbers and the responses. Possibly the sample of respondents does not represent the sub population of adolescents well enough.
Where previous studies show that the older adolescents get, the less active they become (Sallis, Prochaska & Taylor, 2000) this survey does not show similar results. As said before it is possible that this sample is not as representative of the target group as would have been desired.

When excluding physical education, which cannot be undertaken in public space, walking, cycling and ball sports appear the most important activities of these respondents. When asked directly,

Figure 22 | Word cloud of favourited physical activities in outdoor public space

Figure 23 | Word cloud of other important aspects in public space to engage in physical activity

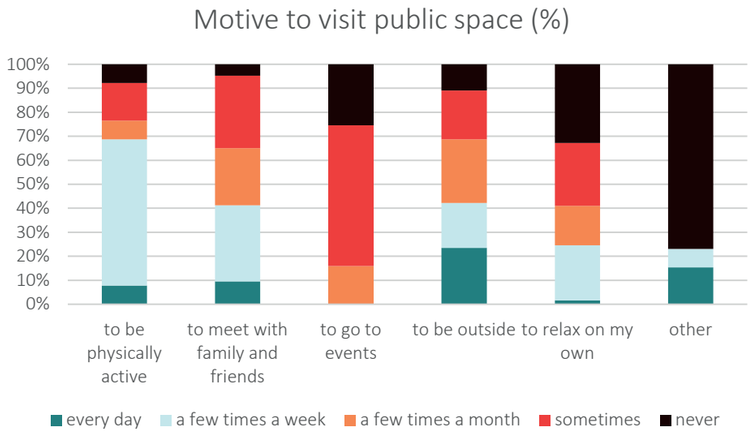


Figure 24 | Preferred environment for activities, 'nowhere' excluded.

respondents tend to think of playing sports and walking as their favourite physical activities to do in public space. See Figure 22. This follows their reported physical activity levels. Unfortunately 'play sports' is not very specific, and does not give much more information on the type of equipment or space required.

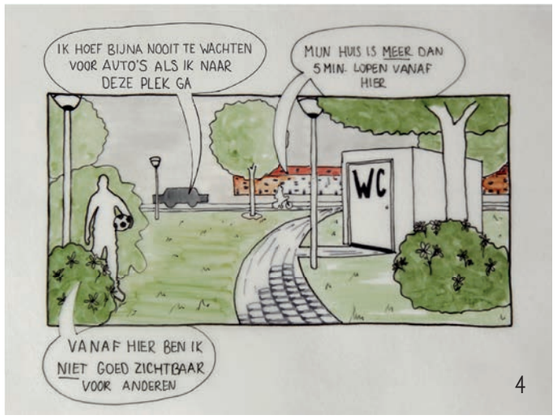
Respondents were asked how often they go to a public space for specific reasons. For the motive 'to be physically active' Figure 24 shows that respondents predominantly visit public spaces each week, but not every day. Good to see is that almost all respondents visit public space a certain amount to be physically active. Public spaces are thus *already* used for physical activity. Therefore it can presumably indeed contribute to increasing activity levels. Almost 66% of the responses state that they do not prefer to do the physical activities they currently do in another location. However, of the respondents that *would* like to do activities in a different location, they often prefer to do this outdoors. This is an opportunitiy for the design of public space. For ball sports, walking, and to a lesser extent athletics and cycling, respondents prefer to do this outdoor instead of indoor.

12% of filled in barriers to engage in more physical actitivity than currently were related to the absence of suitable public space closeby. The ones selected most often were a lack of time, or motivation, and the fact that respondents thought of themselves as already active enough. Considering the amount of physical activity undertaken by the respondents presented before, this last barrier is quite logical. The fact that there still are several respondents stating a lack of appropriate space outdoor as a barrier to be more active is promising for the value of public space for physical activity.

Figure 23 shows what other elements respondents thought to be important for a public space to go there to be physically active. Dominating themes in the answers were related to an attractive space, with the presence of nature and water. Safety appeared to be important too, and a well maintained space. There should be enough room to do things, the space should be well maintained. Remarkable was that several respondents also thought of 'peaceful places' or 'peace' to be important to visit a space to be active.

To enable specific types of activities, specific types of space are required. For walking and cycling the routing network is important, and the attractiveness and safety of this network. Inside the public space walking and cycling can be enabled by including paths connected to other slow traffic networks outside the public space, and designing a safe and attractive public space. For ball sports and athletics the network is less important and the focus can be on the public space itself. Facilities for these activities can be combined with the design of an attractive and safe place to stay.

The results of the individual survey questions which are not shown here are presented in Appendix A-7.



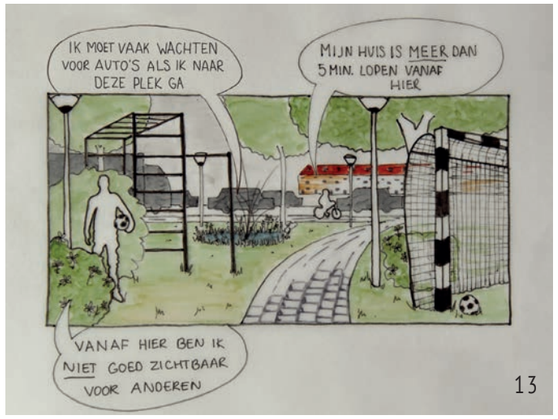


Figure 25 | Profile 4 is valued highest *as compared to* the no choice alternative; profile 13 lowest.

Alternative	Name	β	Significance
No choice	ASC_P0	0 (fixed value)	
4	ASC_P4	1.6	2.22E-09*
15	ASC_P15	1.54	4.72E-08*
3	ASC_P3	1.5	3.81E-08*
1	ASC_P1	1.48	1.23E-08*
9	ASC_P9	1.46	8.82E-08*
6	ASC_P6	1.45	0.000000172*
5	ASC_P5	1.39	9.35E-08*
7	ASC_P7	1.38	0.000000125*
12	ASC_P12	1.35	0.000000241*
2	ASC_P2	1.33	0.00000116*
10	ASC_P10	1.3	0.00000342*
16	ASC_P16	1.3	0.00000118*
14	ASC_P14	1.28	0.00000082*
11	ASC_P11	1.26	0.00000172*
8	ASC_P8	1.21	0.0000109*
13	ASC_P13	1.19	0.00000672*

Figure 26 | Estimated β-coefficients for each alternative as compared to the no choice alternative for model #1.
* = p < 0.1

5.2 User Preferences for Physical Activity in Public Space

As explained before, the main objective of the survey in this thesis is to find out the relative importance of the ten specific spatial attributes for outdoor physical activity according to the respondents. To find this out all observations of the choice based conjoint experiment in the survey are analysed using a multinomial logit regression (MNL) analysis. Several MNL-models are estimated, of which the results of the basic model (#1) can be found in Figures 26 and 27. With the same 309 observations four more models are estimated for boys and girls separately, and for two complementary age groups. To create two sub samples of comparable size, the models for age groups are estimated for children under 16 years old, and the respondents of 16 and 17 years old.
The model specification to estimate the basic model and the results table can be found in Appendix A-8.

MODEL SPECIFICATION

The total utility is the dependent variable, meaning the value the respondents give the specified alternative based on how much they think they would like to visit that space for physical activity. Each alternative has a β-coefficient, showing the relative value of the alternative as compared to the no choice alternative in the choice set. Therefore the β-coefficient for the no choice alternative is fixed to zero. Each spatial attribute also has a β-coefficient, showing the relative value of the attribute as compared to the other attributes. The spatial attributes all contribute to the total utility which is seen in the value and direction of the β-coefficient. The greater the value (either negative of positive, dependent on the coding of the attributes), the greater the contribution of this attribute to the total utility. The utility per alternative can be calculated by adding the β-coefficient of the alternative to the multiplication of the β-coefficients of each attribute times its value (either -1 or 1).

For this project a significance of 90% suffices, this corresponds with a p-value of below 0.1.

RESULTS

Each choice set consisted of two randomly selected profiles and a so called no choice alternative "neither one of these". 36 of the 309 observations have selected the no choice alternative, which is 11.7%. Figure 26 shows the estimated β-coefficients for each alternative. Each of these values is a relative value compared to the no choice alternative. The fact that all β-coefficients are positive, means that respondents would value each alternative higher than the no choice alternative. In all cases this is significant, the p-values are even smaller than 0.01. As compared to the no choice alternative, alternative number 4 is estimated with the highest difference and alternative 13 with the lowest difference. The composition of alternative number 4 is valued most as compared to the no choice alternative. These alternatives are displayed in Figure 25.

Figure 27 shows the estimated β-coefficients of each spatial attribute used in the choice based conjoint analysis. It shows to what extent each attribute contributes to the total utility. Because the total utility has no absolute unit, it is only possible to value each β *as compared to* the other ones. Vegetation has the highest

Sample	309
Rhosquared	0.223

Attribute	Level	β	Significance
Vegetation	little to no green and little variety	-0.403	0.000000846*
Opportunities for physical activity	little to no opportunities to be active	-0.368	0.0000142*
Physical barriers	only small roads alongside the public space (no waiting time)	0.255	0.00275*
Proximity	home is further away than a 5 minute walk	-0.169	0.0458*
Lighting	the entire public space is well-lit	0.152	0.0733*
Water	water features present	-0.125	0.123
Secluded areas	people are visible throughout the entire public space	0.097	0.239
Paths	paths only around the public space	0.0617	0.463
Seating	seating facilities absent	0.0492	0.556
Toilets	public toilet facilities present	-0.0133	0.871

Figure 27 | Results of estimation of attribute parameters in the MNL with the no choice constant fixed. * = p < 0.1.

Alternative	Utility function	Utility value
15	V15	3.134733557
3	V3	2.297958496
1	V1	1.938157049
4	V4	1.87997421
11	V11	1.625244874
5	V5	1.621321596
13	V13	1.469123792
2	V2	1.398821022
7	V7	1.359599719
16	V16	1.256977203
12	V12	1.129722344
14	V14	1.061135057
9	V9	0.694389288
8	V8	0.496473899
6	V6	0.344027977
10	V10	0.313063039
0	V0	0

Figure 28 | Calculated utility functions for each alternative.

value which means that the respondents value a high variety and amount of vegetation most in public spaces. It thus contributes the most to the total utility. Physical barriers are more important than e.g. water features, but less important than the opportunities a public space has to have. The direction of the association is dependent on the coding of each attribute and is as compared to the attribute level with value 1 (over -1). A negative β-coefficient indicates a preference in the direction of the attribute level which has the code -1, i.e. the negative code. A positive β-coefficient indicates a preference for the attribute level with code 1.

There are five spatial attributes that significantly contribute to the total utility. The attribute with the highest β-coefficient and thus the highest contribution to the total utility is vegetation. The presence and variety of vegetation positively contribute to the preferences of the respondents for physical activity in public space. Then it is important to have sufficient opportunities to be active in public space, such as goals and equipment for specific activities. Physical barriers appeared to be important, but already showed a lower value than the first two attributes. This means that it positively contributes to the total utility when physical barriers around the public space that adolescents have to wait for ar absent. But the alternative with physical barriers and opportunities for physical activities will have a higher total utility than the one without physical bariers and opportunities to be active. The final two significantly important spatial attributes are proximity and lighting. The values do not differ much; proximity -0.169 and lighting 0.152, meaning that they are almost equally important. A public space within a five minute walk from home is positively contributing to the total utility. For lighting it is positively contributing that the entire public space is well-lit, and there are no dark spots. The other attributes are contributing to the total utility, but are not significant. It cannot be stated that in 90% of the time they are positively or negatively contributing to the total utility as their β-coefficient suggests.

For each alternative the total utility is calculated. The calculation can be found in the model specification in Appendix A-8. Figure 28 displays the values and ranking of the utility. The utility for the no choice alternative is zero, as it was fixed for estimation purposes. The alternatives with the highest and lowest utility are displayed in Figure 29 and 30.
A few things are important to note: First, there are relatively large differences between the alternatives. Conform the importance and significance of each spatial attribute (see Figure 27), the alternatives with the highest utility have (a variety of) vegetation present. There are equipment and facilities to play sports present, and either their home is closeby or there are no physical barriers present. The alternative with the lowest utility shows a predominantly paved space without any facilities for adolescents to be physically active. And with a road where they have to wait for around the public space and outside the five minute walk buffer.

The utility of the no choice alternative consequently is zero, as the b-coefficient of this alternative has a fixed value. Haaijer, Kamakura & Wedel (2001) discuss that the value of the no choice constant as compared to the other estimated parameters can also

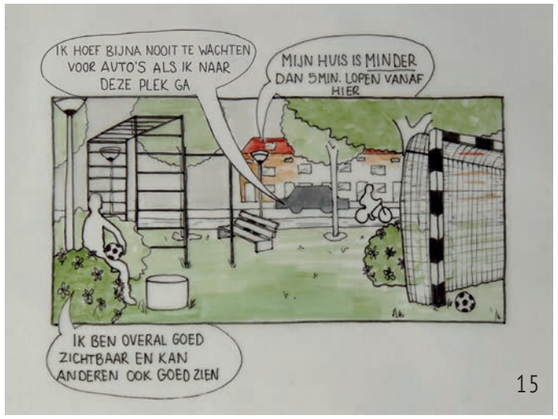


Figure 29 | Alternative with the highest utility

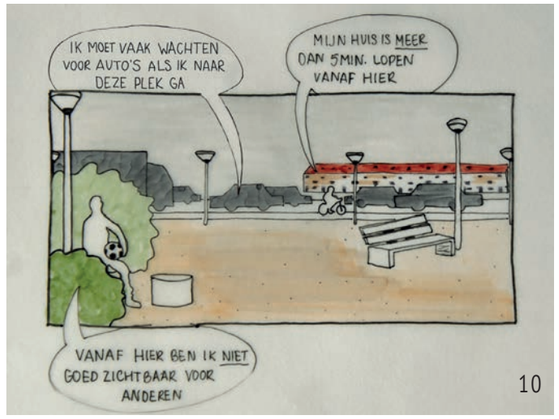


Figure 30 | Alternative with the lowest utility

Sample	134		age < 16 yrs
Rhosquared	0.206		
Attribute	**Level**	**β**	**Significance**
Vegetation	little to no green and little vegetation	-0.359	0.00637*
Proximity	home is further away than a 5 minute walk	-0.357	0.0093*
Opportunities for physical activity	little to no opportunities to be active	-0.287	0.0355*
Lighting	the entire public space is well-lit	0.238	0.0934*

Figure 31 | Estimated β-coefficients of model for children younger than 16 years old.

Sample	175		age > 15 yrs
Rhosquared	0.305		
Attribute	**Level**	**β**	**Significance**
Opportunities for physical activity	little to no opportunities to be active	-0.538	0.0000212*
Vegetation	little to no green and little vegetation	-0.524	0.0000162*
Physical barriers	only small roads alongside the public space (no waiting time)	0.312	0.0107*
Water	water features present	-0.197	0.0865*

Figure 32 | Estimated β-coefficients of model for children of 16 and 17 years old.

give an indication of the total utility of the no choice alternative. In the estimated model the no choice alternative has a fixed value of 0. However, the values of the other alternatives (ASC_P1 to ASC_P16) are all positive and in a small range relatively far away from zero. It can be concluded that the respondents very often prefer a public space alternative over the no choice option. The relative small utility of the no choice alternative can also be seen in the percentage of observations where the no choice alternative has been selected which is only a very small value: 11.7% (Haaijer et al., 2001).

DIFFERENCES IN AGE AND GENDER

The sample has been divided into boys and girls, and in children under and over 16 years old, to see if there are differences in spatial preferences. The figures only show the significant attributes.

Figure 31 and 32 show the significant β-coefficients of the models for adolescents younger than 16 years old and 16 and 17 years old. A few things stand out. The younger children value proximity much more than the older children. It might be that that younger children are not allowed to go to pulic spaces too far away, where older children may already have a larger range.

For both age groups vegetation is significantly important, and so are the opportunities for physical activity. But the older children prefer to have facilities to be active over the presence of vegetation. It is possible that older children prefer to play sports where younger children sometimes still want to just play around and for that need less equipment.

It is notable that the presence of physical barriers is not that important for younger children as was expected. It is only ranked sixth and not significant. For older children however the absence of road hazards is relatively high valued and significant.

Figure 33 and 34 shows the significant β-coefficients of the models for boys and girls only. For girls only vegetation and opportunities for physical activity are significant. The same attributes are significantly important for boys, but in reversed order. Apart from that boys prefer the absence of physical barriers and a public space close to home.

COMPARISON WITH USED LITERATURE

Figure 35 shows the expected and measured direction of the association of each spatial attribute. Remarkable is that there are some attributes showing a different association than expected. Where e.g. McCormack et al. (2010) argue that water features contribute to the total attractiveness of a public space, and with that encouraging use and active use of green public spaces, these respondents prefer the absence of water features to be active in a public space. The same can be concluded for the attributes paths, seating facilities, and toilets. For these three attributes respondents prefer the absence of them (or only paths around the public space) over the presence. However these attributes were not signifcant to the preferences of the respondents.

It is possible that the size of the sample is partially causing this. Another explanation can be that these attributes are simply less important to adolescents. Except for the attribute of paths, all insignificant attributes were derived from the literature not specifically targeting adolescents. It is possible that, despite what could be concluded from the literature review,

Sample	171		boys
Rhosquared	0.241		
Attribute	**Level**	**β**	**Significance**
Opportunities for physical activity	little to no opportunities to be active	-0.403	0.000349*
Vegetation	little to no green and little vegetation	-0.388	0.000642*
Physical barriers	only small roads alongside the public space (no waiting time)	0.346	0.00414*
Proximity	home is further away than a 5 minute walk	-0.225	0.0591*

Figure 33 | Estimated β-coefficients of model for boys only.

Sample	133		girls
Rhosquared	0.217		
Attribute	**Level**	**β**	**Significance**
Vegetation	little to no green and little vegetation	-0.381	0.00315*
Opportunities for physical activity	little to no opportunities to be active	-0.31	0.0273*

Figure 34 | Estimated β-coefficients of model for girls only.

Attribute	Attribute level = 1	Expected direction of association	Measured direction of association	Significant with p < 0.1
Vegetation	little to no green and little vegetation	negative	negative	yes
Opportunities for physical activity	little to no opportunities to be active	negative	negative	yes
Physical barriers	only small roads alongside the public space (no waiting time)	positive	positive	yes
Proximity	home is further away than a 5 minute walk	negative	negative	yes
Lighting	the entire public space is well-lit	positive	positive	yes
Water	water features present	positive	negative	no
Secluded areas	people are visible throughout the entire public space	positive	positive	no
Paths	paths only around the public space	negative	positive	no
Seating	seating facilities absent	negative	positive	no
Toilets	public toilet facilities present	positive	negative	no

Figure 35 | Expected and measured direction of association of each spatial attribute related to the attribute level that has been coded as 1.

these attributes are not as important for adolescents as the significant attributes after all and as these attributes are for other target groups. They can still play a role, but relatively small as compared to the significant, and often from adolescent specific literature, attributes.

The exception to this is the attribute of lighting. The presence of lighting is positively contributing to the total utility, according to the respondents. Lighting was explicitly mentioned in the literature on the perspective of green space use for physical activity in general as a measure to increase perceived safety. McCormack et al. (2010) e.g. show several qualitative studies where the presence of lighting is positively contributing to the use and / or use for physical activity of parks in general. The survey results show that for adolescents this too is important, as respondents also indicated the importance of a safe place in the open questions. The adolescent specific literature did not explicitly found variables regearding lighting facilities, but they can be included in the perceived safety variable as researched by Davison and Lawson (2006), which was inconsistently or not related to adolescent physical activity behaviour.

PHYSICAL BARRIERS

The presence of physical barriers respondents had to wait for appeared to decrease the total utility. Respondents prefer to only have smaller roads to cross on their way to the public space. Physical barriers were often researched in the reviewed literature, both on adolescents specifically and on the use of green public space for physical activity in general. Associations were inconsistent (e.g. Ding et al., 2011) or inverse (Davison & Lawson, 2006). Davison & Lawson (2006) e.g. found that children (no distinction between children and adolescents) appeared to be more active when traffic was not a big issue: lower density, less roads to cross, and less crossings without e.g. traffic lights. This corresponds to the survey results.

Furthermore do respondents prefer their home within a five minute walk. Proximity to several public spaces (parks, green spaces, recreational facilities) in the literature was either positively or inconsistently associated with (adolescent) physical activity behaviour (e.g. Ding et al., 2011; Schipperijn et al., 2010). Davison and Lawson (2006) have found proximity-related variables in five studies. Three of those showed a positive relationship with child activity behaviour and two showed no association at all. Schipperijn et al. (2010) showed in a nationwide Danish study that frequency of use of green spaces for either type of activity decreases immediately when distance to the space increases. Although results are sometimes mixed, proximity to public space appeared to be of importance in literature too.

VEGETATION

The presence and variety of vegetation showed to be the most important spatial attribute in the MNL. According to the literature on green space use, vegetation can contribute to the attractiveness of a public space, and with that attracting people to visit (e.g. Hartig et al., 2014). The survey results seem to substantiate this, as respondents also stated nature as an important aspect in the open questions. In the adolescent specific literature, e.g. Ding et al. (2011) did include vegetation specifically, but as they only found a very limited amount of studies, and only a

limited positive association, this was not even included in the review in paragraph 3.1. Apart from this, vegetation was only indirectly included in the variables, e.g. the accessibility and density of and proximity to parks from Ding et al. (2011). Overall vegetation increases the attractiveness of a public space, but the relationship with (adolescent) physical activity behaviour remained inconsistent in the literature, although from this survey it showed the most important attribute.

OPPORTUNITIES FOR PHYSICAL ACTIVITY

The only spatial attribute included by Sallis et al. was "opportunities to exercise", which was positively related to adolescent physical activity behaviour (2011, p.969). Other adolescent specific literature showed again a positive, or inconsistent relation with the presence of opportunities for physical activity (Davison & Lawson, 2006; Ding et al., 2011). Remarkable is that there are studies that show no relation between facilities or equipment for physical activity and actual activity behaviour (e.g. Dunton, 2003 as cited in Davison & Lawson, 2006, p.5). The survey results show that the respondents *do* think opportunities to be active such as a sports field or fitness equipment is important to actually be active.

When comparing the survey results with the used literature it is difficult to explicitly state similarities or differences. Because the adolescent specific literature used are all reviews in itself, they often only found inconsistent relationships because there always are some studies that did not find a relation. Differences in the underlying studies itself, such as how the variables are measured, and how associations are estimated or calculated, make it difficult to compare the findings.

A note should be made that the different attributes can cause a conflict. While respondents often asked for nature and vegetation inside a public space, they also find safety important. Too much vegetation, especially large bushes can make people feel unsafe because of their invisibility. On the other hand can the presence of plant beds and trees create a quiet and peaceful place because the rustling trees provide contra sounds. A balance should be sought as there is no one-size-fits-all solution.

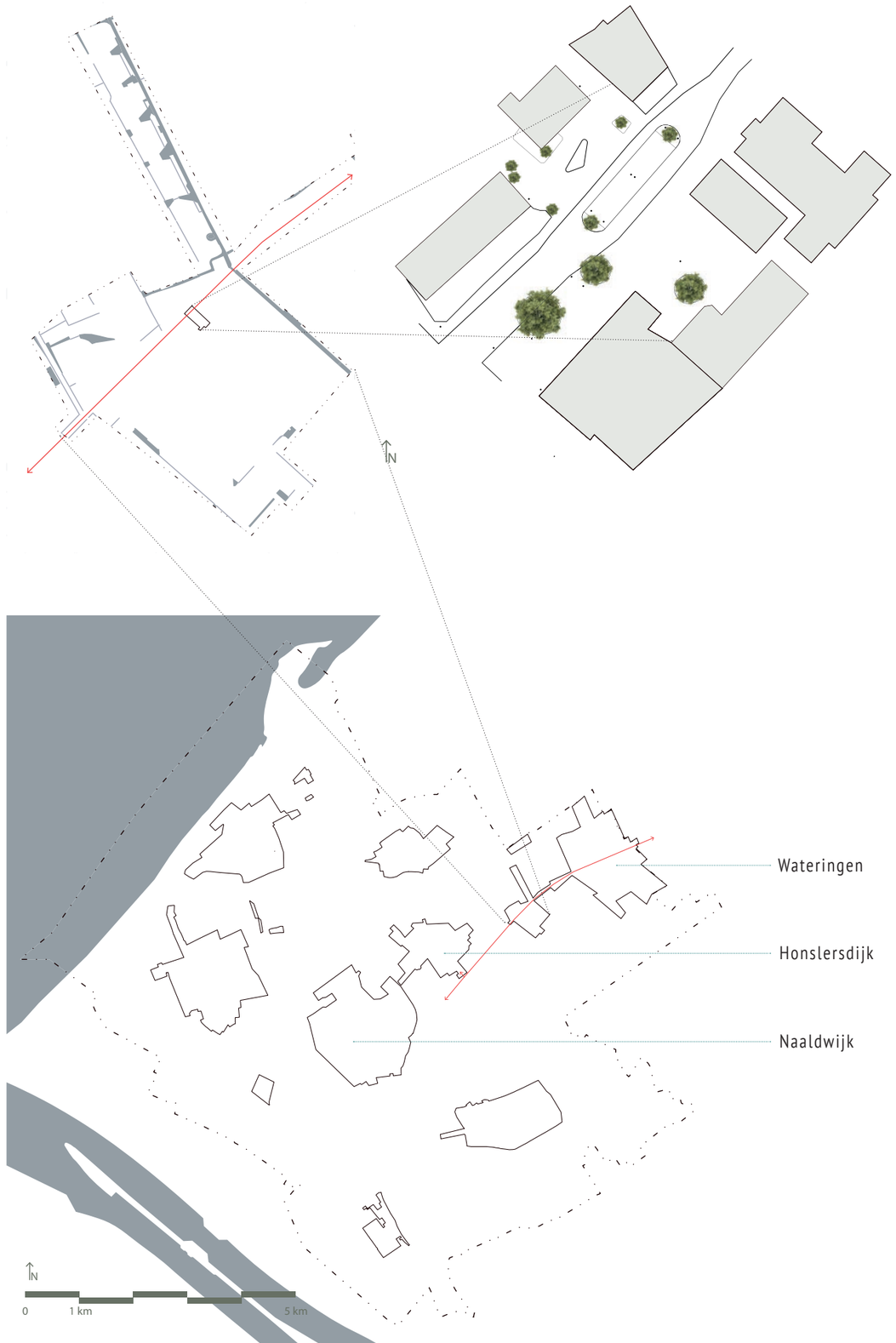


Figure 36 | Location of square in Westland (bottom) and Kwintsheul (top left) and plan of square (top right).

06 | Transformation of Space

6.1 Selection of Square

The results of the choice based conjoint analysis, and of the other survey questions are used for the transformation of a specific public space in Westland to illustrate how this research method can give input for urban design. To illustrate the translation of the research findings, a square in the core of Kwintsheul is selected. The preliminary survey results showed the importance of nature and facilities to be physically active. Therefore a type of space has been selected that does not meet these criteria.
With almost the entire square paved, no explicit opportunities to be physically active, and a decent amount of space centrally situated in the core, it was assumed that this square could benefit from a transformation.

Figure 36 shows the situation of Kwintsheul in Westland and the situation of the square in Kwintsheul. Kwintsheul is one of the smaller villages in Westland with around 4,000 inhabitants (CBS, 2019a). This square with its direct surrounding buildings is the only central area in Kwintsheul. It is situated around a main road, connecting the villages of Wateringen and Honselersdijk/Naaldwijk.
The images on the give an impression of the situation and functions surrounding the square. Shops and businesses are adjacent to the square, including the only super market of Kwintsheul. The main road divides the square into two parts.

Figure 37 | Square from side to side

Figure 38 | Present (blue) and absent (grey) spatial attributes at square

Figure 39 | Existing situation square

Figure 40 | Vegetation combined with seating

Figure 41 | Different types of lighting

6.2 Fitness of Square for Adolescent Physical Activity Behaviour

The ten attributes of the conjoint experiment have been inventoried. After that the fitness for physical activity is determined.

The square is a predominantly empty place where not much is available, and not much is happening. The square has two parts, separated by a main road to get to the other villages. Because the place is paved and empty, it provides an excellent space for physical activity, but there are no explicit opportunities. Because it is all paved there are no specific paths.

There is some variety in vegetation from trees to small plants, including seating arrangements. The amount of vegetation is limited as can be seen in Figure 40. As a result the vegetation does not provide many secluded areas.
However some places are secluded from other places, caused by the form and character of the built area. With only public functions during daytime, the square is mainly surrounded by blind walls at night. (see Figure 39).

There is lighting present at both parts of the square. Especially an area around the supermarket is well lit. Some areas further at the back and alongside blind walls are darker and more secluded (see Figure 41).

Figure 42 | Square (in pink) with proximity radius of a five minute walk.

Figure 43 | Barrier road dividing two parts of square

The road dividing the two parts is a main barrier. Although it is not a road with multiple lanes, it is a busy one where people often have to wait before they can cross it.

Water features are absent as are public toilets.

Figure 42 shows a radius of five minutes walking distance from the square. The majority of housing in Kwintsheul is contained in this circle.

Following the results of the multinomial logit regression analysis, this square currently has no good fit for adolescent physical activity behaviour. The most important attributes, vegetation and opportunities, lack.

Figure 44 | Transformation of square

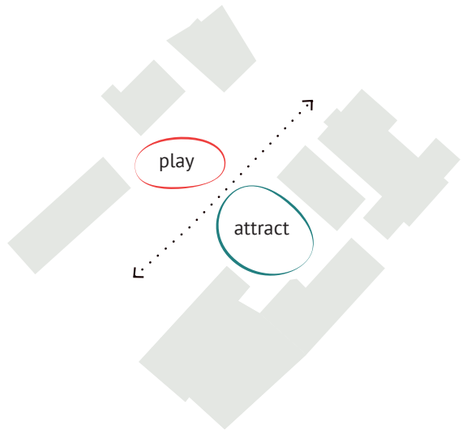


Figure 45 | Concept of transformation

Figure 46 | Example of sports field according to the Athletic Skills Model (Athletic Skills Company, 2020)..

6.3 Transformation of Square

The objective of the transformation was to decrease the negative impact of the road and to separate the functions attract and play to create a variety of opportunities for physical activity (see Figure 45).

The attract function is located there because of the proximity to stores. The stores also have a social function, which complies with the attract function.
The square is made a destination within the slow traffic networks by moving the 'fietsknooppunt' and 'wandelknooppunt' of existing networks to it. This way the square becomes an actual part of the routing network, attracting more people. By adding vegetation and paths the square becomes an actual part of the slow traffic network.
Existing lighting was reasonable, and has been increased to compensate for added vegetation and less clear lines of sight.

The other side of the road has less interfering activities making this a good location for the play function. The adjacent community center may use the added facilities for physical activity. A possibility is to add a sports field according to the athletic skills model. The Athletic Skills Company developed playing fields see Figure 46 (Athletic Skills Company, 2020). With a colourful underground and various equipment different forms of play are facilitated. This challenges adolescents and children to invent their own types of play and teaches them how to better move.

To illustrate how to cope with a road barrier going through the public space, it is not rerouted. This would have relocated the traffic problem. The profile is adapted to make it as unattractive and inconvenient

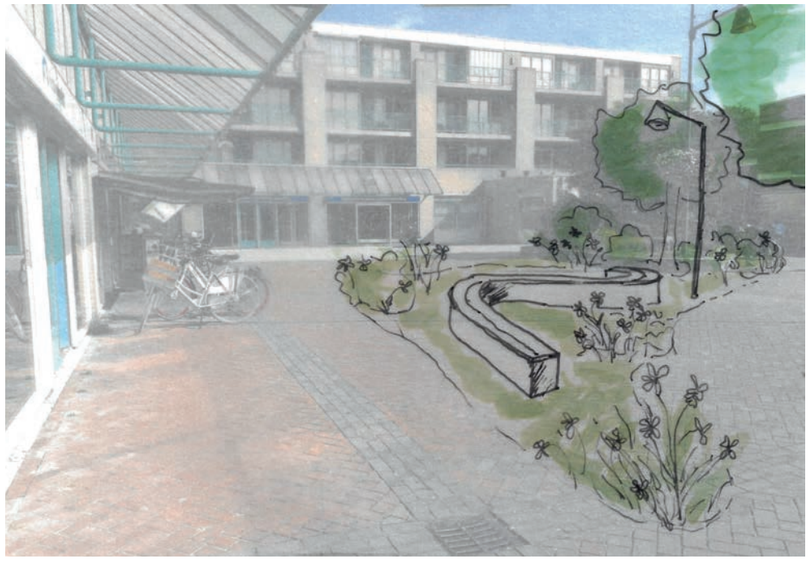


Figure 47 | Adapted square - attract part along the shops.

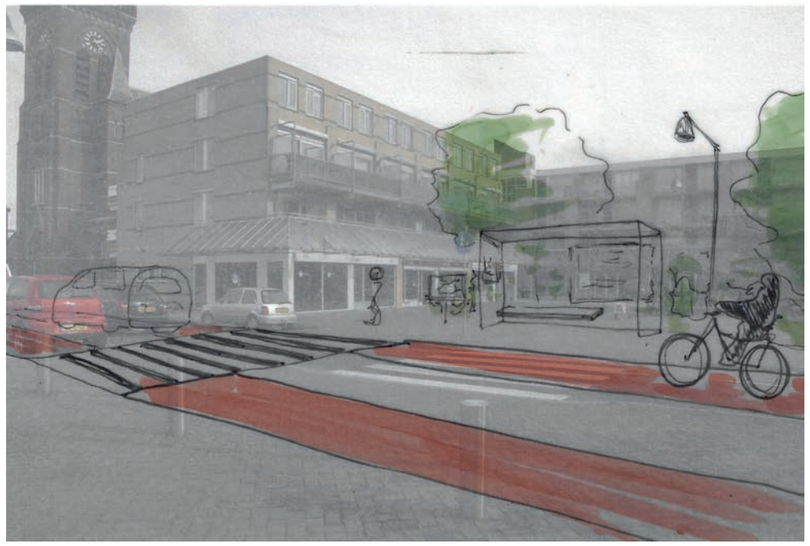


Figure 48 | Adapted square - relocation of road along the attract part of the square.

as possible to take this road when just passing through Kwintsheul. From the church to the parking at the other end of the square the road is heightened to the level of the sidewalk to discourage motorists to use the road and to speed. The focus is on people more than cars. Separating traffic flows in height seems unsuited for a small village center.
The parking lots at the center of the road which even more separates the two parts of the square are moved to the existing parking lot. This opens up the square for public functions and connects the two parts.

To create unity between the two parts of the square, the interfering road is paved identical to the square except for the bicycle path. Vegetation and urban furniture are similar on both parts too.

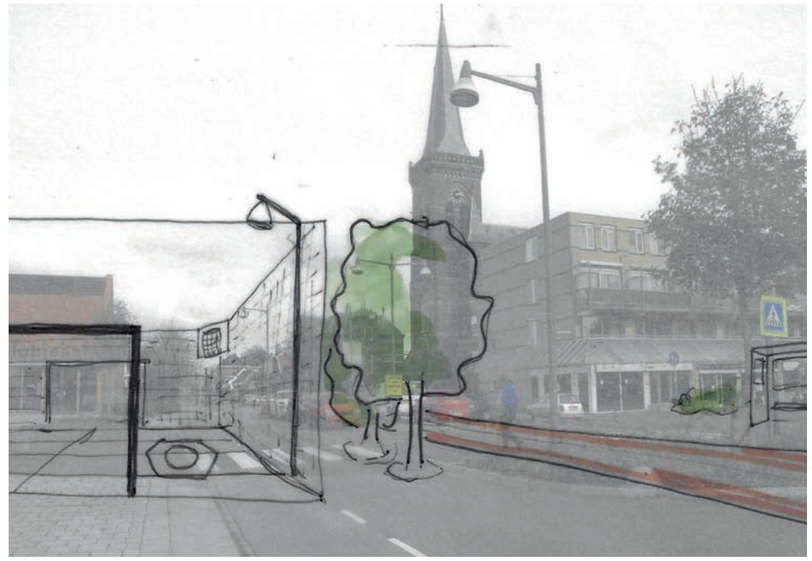


Figure 49 | Adapted square

Sports area at the edge of Kwintsheul (2020).

In this final part we look back on the project and process. First the main research question is answered and it is discussed what this could mean for practice and for the field of urban research and design in general. Finally the project and process of the graduation are reflected upon.

PART 04 | CONCLUSION

07 | Conclusion and recommendations

Main Research Question

How can the public space in Westland, the Netherlands, be adapted to better meet the spatial demands of adolescents for physical activity behaviour?

The role of urban design of public space to contribute to coping with physical inactivity among adolescents is explored in this thesis. Knowledge from prior empirical research showed the physical environment as one aspect influencing physical activity behaviour. Even when only looking at the physical environment there already is a high variety of different influencing variables. This means that there is a lot to tweak and adjust. Understanding the elements that are important for different target groups is useful to precisely intervene in the urban fabric. Ten spatial attributes were identified from prior research to use in a choice based conjoint experiment. The results of this statistical analysis have led to an understanding of the relative importance of these attributes for physical activity in public space according to adolescents. Five out of ten spatial attributes appeared significantly important ($p < 0.1$).

The most important attribute was the vegetation. The presence and variety of vegetation were positively contributing to the preferences of the respondents. The second attribute which was signifcantly contributing to adolescent physical activity behaviour was the presence of a lot of different opportunities to be active, such as sports fields and fitness equipment. Based on other open questions on favourite activities survey respondents specifically seem to value opportunities to play sports, more specifically soccer, and to walk. It is remarkable that adolescents have reported to prefer the presence and variety of vegetation to be more important than the facilities for them to be active.

Based on the respondents' preference for walking it was expected that the presence of paths throughout the public space would be important to create the opportunity to walk. The statistical analysis however showed that respondents only preferred paths *around* the public space instead. A note should be made that the value of the spatial attribute paths was not significant.

The other spatial attributes that were significantly adding value to the public space according to the respondents were (1) the absence of main roads they have to wait for before crossing; (2) the presence of lighting; and (3) the public space within a five minute walk from home. It is interesting to observe that attributes that were derived from prior research and showed insignifcant in the survey were often from studies not targeting adolescents specifically.
The differences in methodology make it difficult to compare studies. Different attribute definitions, methods to measure attributes (reported or using GIS), and indicated relations with physical activity make it difficult to explicitly state that one or more attributes are crucial. It seems

context specific.

The significant attributes were used to transform a square in Westland to illustrate how the results of the research part can be implemented in urban design. Not only the attributes are important to consider, but the existing composition and context of the space should be taken into account as well. A quantitative study to infer expected user preferences is not an alternative for the design of space. A valuable and necessary contribution of the urban designer is the translation from research findings into tailor-made interventions. With the knowledge of *what* attributes are important an urban designer can define *how* they are embedded in the spatial context.

Value of Quantitative Research in Urban Research and Design

The use of a statistical method that was not specifically designed and defined for urban research and design can be very valuable. The choice based conjoint experiment enables an urban designer to indirectly ask for user preferences before realising a design. User preferences give other valuable knowledge than correlations only between the physical environment and physical activity behaviour. One gets a better understanding of the target group to design for and this can be used to underpin the design. Two things are important.
First the careful selection and definition of the attributes included in the experiment. Respondents might include other attributes in their choice of an alternative. Although this is part of their reasoning for choosing, it is not measured in the experiment. As Boumeester et al. (2008) state this can distort the results.
Second, the interpretation of the alternatives (text and image) is influenced by respondents' frame of reference. It can be very helpful to use images over text only, but it is important to take into consideration that interpretation can differ among respondents.

Recommendations

A few recommendations can be given based on this graduation thesis, regarding the urban design, using of the MNL results, and further research.

In existing urban fabrics, changes can be made to better fit the preferred spatial quality of adolescents to be physically active in public space. Two approaches can be distinguished. First it is possible to adapt spaces that already fit a little bit and optimise them. Parks and nature areas already have (a variety of) vegetation present, and often reasonable room to add facilities. A second approach is to change the function of existing spaces. Vacant plots or left over green fields can be transformed. With this approach can also be reacted to the importance of proximity.

In new to be developed urban fabric is the location of public space essential. The importance of public spaces within a five minute walk from home, and without road barriers that impose waiting times, ask for thoughtful design. In new urban fabric the opportunity exists to separate the main roads and public spaces, and ensure a safe access.

Be careful when assessing the public spaces in terms of the spatial attributes. Consider the presence of absence of the attributes together with its composition and appearance. It is possible that there are attributes present, but targeting a

different group of people, e.g. play areas with swings and slides for smaller children. Make sure to be cautious of conflicting attributes, e.g. the presence of high bushes and perceived safety.

Further Research

This was a very interesting attempt to use a quantitative method to identify user preferences in urban research and design. The method of choice based conjoint analysis can be developed further. A few interesting approaches are to:

(1) Research the use of virtual reality to clarify the public space alternatives. Instead of only looking at the images, respondents can actually experience the public space themselves.

(2) Evaluate the transformation of the public space with the respondents afterwards.

(3) Finetune the definition and selection of attributes. Perhaps research a specific activity type, and increase the attribute levels to understand the importance of the attribute composition.

(4) Investigate the preferences for spatial networks with respect to single public spaces. The literature considers network variables too, and the nature of activities like cycling, running and walking require more than a single public space.

Bottom line is that there is much more interesting research to do about the topic of (adolescent) physical activity and the urban form. In times that people are still too inactive, and where we might become more dependent on public space for physical activity, there is always work to do.

08 | Reflection

8.1 Adolescent Physical Activity Behaviour and Urbanism

Engaging in pysical activity is directly linked to urbanism: every form of activity requires a specific type, amount and composition of space. The space the physical environment provides, can facilitate or hinder specific physical activities. Public spaces such as parks or squares, and transportation networks such as cycling networks enable people to undertake physical activities in the outdoor environment. The design of these places and networks influences the accessibility and availability of opportunities to be active, and with that influence the extent to which people engage in physical activities.

With the start of my graduation thesis, health was one of the topics of the studio Design of the Urban Fabrics. Being sufficiently active can be seen as an integral part of healthy citizens as it is beneficial to both mental and physical state. To explore the impact of the composition of urban form on health and behaviour, I had selected this studio to graduate at. Due to some delay because of personal circumstances and a change of mentor team, I was requested to also change my graduation studio to Planning of Complex Cities. As a result the studios have, specifically after changing to Planning of Complex Cities, not played a significant role in my thesis.

8.2 Relation Research and Design

The intention for this graduation thesis was to use design as a research tool and let it be informed by literature and prior studies. And using that knowledge to find out and quantify what spatial aspects adolescents prefer over others to be physically active in public space. Design is used in a quantitative survey to investigate the impact of specific spatial attributes on adolescent physical activity behaviour. Spatial attributes extracted from reviews on prior (empirical) studies on (adolescent) physical activity behaviour are used to develop the survey. Design is then used to visualise and communicate (images of) public spaces with diverse attributes in such a way that they are comparable and yet distinct ive. These designs are informed by prior research findings on adolescent phsycial activity behaviour (see e.g. Davison & Lawson, 2006; Ding et al., 2011). WIth the results from the statistiscal analysis of the survey output, one specific case in Westland is assessed on its fitness for adolescent physical activity behaviour. In the final step design is used to communicate how this specific case can be adapted to better meet the spatial demands of adolescents to engage in physical activity in outdoor public space. Using design in an early stage of the project enabled me to compare the findings of the survey with prior research findings to explore the impact of the local context of Westland. Using the findings from prior research directly in the Westland, would have neglected the impact of the local context on behaviour.

8.2 Methods and Methodology

Due to adjustment of the Dutch physical activity guidelines in 2017 it is difficult to compare with earlier years. Furthermore

are from 2019 onwards numbers on physical activity at school included for adolescents (CBS & RIVM, 2018). For children under 12 this was already the case. This has also led to an increased number of sufficiently active adolescents. With the start of this thesis this was not the case.

In Westland numbers 18-year olds are included in the group of adolescents (at least one hour of physical activity per day), while they are included in the adult group in the Netherlands as a whole (at least 150 minutes of physical activity per week). The reason for this is unknown, but distorted the image of the activity numbers.

LITERATURE RESEARCH

There has been an increasing amount of research on the (spatial) variables influencing (adolescent) physical activity behaviour. I have used several review studies where I found many variables, see Appendix A-3. It took me some time to understand al of these and extract and define the ones to use in this thesis. The use of review studies not always made it clear how theses attributes were defined by the original authors. Another consequence of using review studies is that the quality of the individual studies used in the reviews is not always clear. Methodological differences in studies enlarged the difficulty to compare the findings and define the specific meaning of each attribute.
Furthermore, most reviews found were based on mainly Northern American studies. Thus from the survey lessons are learned on how relevant spatial attributes are in this context as compared to the found literature and predominantly American studies.Using the survey as a test to validate the spatial attributes found in the reviews helps to overcome possible differences in impact related to the location.

I have used two types of research: (1) reviews of adolescent physical activity behaviour, which was not specifically targeting public space. And (2) for the assignment of AR3U023 I wrote a paper on the relationship between green space and physical activity in general, without the target group of adolescents. The variables I found in these sources I have used to put together the ten spatial attribute I use in this thesis. I have made a translation of all attributes to only ten to use in this research. Some attributes are combined to research the essence of the attributes, and others are left out.
In retrospect it would have helped to e.g. have written the theory paper more specified to adolescents, or scope the thesis in an earlier stage to limit myself to a specific amount of literature and knowledge. However, I already started writing this paper before selecting adolescents as a target group, and broadening the scope from green public space to public space.

FINDING RESPONDENTS

The active involvement of the target group of adolescents was an essential part in this thesis. Both to understand their demands for an active friendly public space, and to cope with the differences and inconsistencies in prior research findings. The survey I developed was set up to reach as many adolescents living in Westland as possible through their secondary school. This would have led to a representative group of respondents in the age of 12 up to and including 17. Because of external factors at these schools, this appeared to be impossible to achieve. To still reach as many adolescents as possible, other ways to distribute the survey were used, as explained in chapter three. Eventually I found several alternatives to (digitally) distribute the survey within Westland. With the help of a social organisation ('Vitis Welzijn') and the Youth Counsil of the municipality of Westland. After putting in maximum effort to reach as many Westland adolescents as possible, only 42 useful responses returned. To draw relevant conclusions this was too little. I have then broadened the scope of the survey to the children and/or nieces and nephews of members of the Faculty of Architecture. Unfortunately this was inevitable to be able to draw some conclusions from the survey results.
As a result the survey took a lot more time, and the connection with Westland in the survey was lost. Because Westland still has a larger than average share of inactive adolescents, there still is added value in adapting public space in Westland.
It is acknowledged that the distribution of the survey and the used sample has lead to a non-representative sample of the adolescent population. The survey showing only very few respondents to be physically too inactive is another indicator for the non-representative sample. This is very unfortunate, I also had to continue with the rest of the project. A consequence of the (unforeseen) low response rate was that it heavily influenced the time planning.

SURVEYS

Images and text are used together in the survey with the choice based conjoint analysis. Choice based conjoint analysis enabled me to extract the relative importance of specific spatial attributes for adolescent physical activity behaviour with the use of a multinomial logit regression analysis. The images needed to be distincitive but still comparable, and to be understood by the target group. Using the same elements and layering them to one profile image helped to do so. The images are accompanied by text for the attributes that are not directly visible, such as the presence of physical barriers and if home is nearby or further away. Based on findings by Boumeester et al. (2008) it showed to be important to accompany the images with text in the part of the survey where a choice based conjoint method is used.
Images and text both are very susceptive to interpretation. From the pilot survey it became clear that the attribute of physical barriers was interpreted in various ways. This attribute was drawn by either one or a lot of cars and trucks. It is impossible to demarcate everything and controll all output, but it appears important to carefully define the variables. In the example of the barriers perhaps just the presence of an e.g. four-lane road or not. The value of such attribute for individual respondents is always dependent of their norms and values, and previous experiences. That will always remain, and perhaps is not a bad thing as it shows the importance in a specific context, independent of the value we give an attribute. It is however necessary to take into consideration when defining and visualising the attributes.

Apart from various interpretation, the pilot respondents did not always see or remember every aspect of the image. Even when trying to draw each attribute as simple as possible, without steering the target group to preferences for this attribute. The visualisation of a car (attribute is 'presence of physical barriers') e.g. is made very schematic without suggesting any type or specific characteristics. For a

next time I would try to find out how to develop these images even better to avoid misinterpretation. Perhaps with more knowledge on childrens' understanding of images and how they process this.

Another element that may guide respondents unintentionally is how the spatial attributes are shaped. It is possible that respondents do not want to engage in physical activity in one of the profiles, only because they don't like these types of physical activity. With selecting the two most popular sports among sporting adolescents I have tried to cover the largest share of adolescents being addressed.

8.4 Scope of the project

Overall the scoping the project was a challenge, especially in the beginning when I was just trying to understand the topic. A very valuable lesson I have learned is that elaborating on one aspect can also function as a roadmap for other similar aspects. Therefore instead of analysing the typology of public space as initially thought of, a specific case is used to illustrate the possible transformation of public space.
In the beginning of the graduation thesis it took me some time to get to the topic of adolescent physical activity. Before setting these boundaries, the possibilities to 'do something with heatlh and urban design' were endless, and the amount of literature to review was a little overwhelming. I know that it is impossible to research everything, even in relation to a specific topic of e.g. physical activity behaviour. Clear boundaries, and setting them in a very early stage, and specific goals will help keep the focus and overview.

Sallis et al. (2000) concluded in their review that previous physical activity in adolescents was often positively related to current physical activity behaviour. Seeing that adolescents are the sub population that is the least active in the Netherlands, it might have been more meaningful to focus on children for changing their activity behaviour for the better into adolescence. The adolescent sub population has been selected before finding these results, as they are the ones being the least active both globally and locally. In the next phase of inventory and analyses of public space in Westland, I found that there were a high amount of play areas for younger children, but only little for the older children. It appears that only few public spaces are explicitly designed for adolescents to be active in. Because of this, and to facilitate the continuation of an active lifestyle from childhood into adulthood, adolescents were after all a relevant target group to focus on.

Other boundaries for this thesis were set for the use of space, and the extent of elaborating on a transformation. Although characteristics of the network of public space are influencing physical activity behaviour as well, in the thesis the focus was predominantly on qualities of the public space itself.
Throughout the thesis both public space in general, and more specifically *green* public space have been addressed. The survey even included public and private space to get a complete image of the location of respondents' activity behaviour. The spatial analysis initially comprised of *all* types of public space for staying (no streets), and the final transformation covered only one public space. A non-green public space was selected to increase the possible impact of the transformation. As green public space is a more specific scoping within public space they perhaps cannot be separated. To use the importance of green space it was assumed that this would have a higher impact on non-green public spaces.
For this the same applies as said before: it is important to set boundaries for the different stages in the thesis in an early stage. In order to do so, basic knowledge on the topic, relevance and issues are necessary to gain first. Another important aspect is however also to be flexible with these boundaries when necessary.

8.5 Ethical Considerations

To ensure the safe and careful handling of the information retrieved through the survey, an ethics application has been handed in for approval. Although I was only pointed to safety and security issues by one of the secondary schools I approached, I retrieved helpful information from both data steward and privacy consultant of the University afterwards. It appeared to be quite complex and time consuming to find all information necessary and make early decisions about data storage, use of software, and the distribution of the survey. However, I wanted to fill it in with care and be as specific and transparent as possible both in the ethics application and the survey. Although my main objective for the survey was very honest to just understand what the target group thinks and how I can better design for them, this extra attention to privacy and security made me aware of the impact of my survey and specific questions. I needed to keep finetuning them to create a balance in the risk of identification and the fitness of the information I could retrieve from the survey.

8.6 Value of Urban Design

Behaviour is very complex because of a high variety of influencing factors, and behavioural change is dependent of a lot more than just the (transformation) of the physical environment. Researched barriers for adolescents to be active are often not related to the physical environment, but to time and motives (Visser, Duijf, & van den Dool, 2019). The survey results showed similar constraints. Urban design will probably not be effective when people do not want to be active. However, increasing the ease of using outdoor spaces for physical activity, and developing attractive spaces that are suited to be active in might increase the use of these spaces. The transformation of the physical environment can potentially reach large amounts of people at once: people that live closeby or pass through the space every day. But, there always has to be that one early adaptor to start the use.
It is suggested earlier in this thesis that there is not been done enough yet to contribute to decreasing inactivity. Complex issues should therefore be addressed in multiple disciplines and at multiple scales, and therefore each step is important.

The COVID-19 pandemic has not caused many notable issues for the data collection. What is interesting is how this virus changes, and further will change in the future, the use of public space. What role will public space play in a society where we need to keep our distance from one and other, and where each individu thus takes up more space than before. More specifically for people as a place to engage in sports or other physical activities. Especially in times where sports facilities can only accommodate for a limited amount of people, different opportunities to engage

in physical activity are required. People can become more dependent on the public space or their home for physical activity. With that the urge to develop space in favour of the people and their living rises.

8.7 Value of Results and Transferability

Only main effects are estimated in the used models. This means that the impact of the attribute level of one attribute on the importance of another attribute could not be estimated. Practically speaking, e.g. the value of the presence of opportunities for physical activity can be influenced by the presence or absence of lighting. The choice of using a fractional factorial design (only main effects) over a full factorial design (also interaction effects) mainly was because of the smaller attention span of the children.
Apart from that, the attributes I have not included can play a role as well in the choice of the respondents. As Boumeester et al (2008) explain, this could distort the results as well: they argue that the respondents will include this themselves based on their understanding and interpretation of these other attributes. To scope the research this selection of ten attributes has been made, but in future research this needs to be taken into account. It remains important to be careful in the selection of attributes and attribute levels.
Respondents take into consideration their previous experiences, values and norms to make a choice always, but when estimating only main effects (no interaction effects), this cannot be measured and analysed.

In the end the survey returned 65 useful responses. With each response having answered five choice sets, this would have led to 325 observations to analyse. Some observations were excluded because of them not being answered. This led to 309 observations for the analysis, instead of the desired 1,000 (with 200 respondents). Boumeester et al. (2008) explain that they used two holdout choice sets per respondent (12 choice sets in total). These are extra choice sets used to validate the model that is the result of the analysis. This would have required either more responses or more choice sets per respondent. Because of the attention span of the children, the latter option has been left out beforehand. Unfortunately the response rate was not that high to enable using one observation per respondent for this validation. Therefore the model could not be validated. It is acknowledged that this would strengthen the results, but appeared not possible.

The choice based conjoint experiment is not asking explicitly for user preferences. Respondents are asked to choose a complete image instead of naming specific characteristics they think are important. It is possible that they are therefore less inclined to give socially desirable answers and choose a complete image unconscious of specific components of that image.

It appeared difficult to compare the results to the used literature, as the spatial attributes used in the thesis are almost nowhere taken one on one. Apart from that, the adolescent specific literature used were reviews only, these findings can only be compared to these reviews and not to individual studies.

The survey has given insight in specific spatial attributes that appeared more important than others for adolescents to be active in public space. With these results one specific case has been selected that is, based on the preliminary survey results, not fit in its current form. This square is adapted to fit the results of the choice based conjoint analysis. It is used specifically to illustrate how this research method can extend its functionality into design. Due to the time consuming task to specify the right model for the MNL analysis, less time than desired remained for the transformation of space.

The survey has not given insight in very specific public spaces that are either good or bad for adolescent physical activity behaviour. Much more did it give insight in general characteristics of the space that respondents thought to be more or less important. Because of the broadening of the scope of the targetgroup from Westland adolescents to adolescents in general, the results can potentially be used elsewhere in the Netherlands too. However, the fact that almost all respondents were more active than average and advised, and because of the quite small size of the sample, it is recommended to extend this research. Another aspect to further research is the composition of the specific attributes. Because the attribute levels in the survey were often present or absent, the survey did not give insight in how these attributes should look like according to the adolescents. It might be interesting to take this a step further and evaluate the transformation of the public space *with* the target group. Or even design it with the target group together.

Wilhelmina Square in Naaldwijk (2020).

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Small scale park in Honselersdijk (2020).

APPENDICES

Figure A | Physical activity guidelines visualised for children (top) and adults (bottom) (Kenniscentrum Sport, 2019, retrieved October 25, 2020, from https://www.kenniscentrumsportenbewegen.nl/wp-content/uploads/2019/12/Infographic-beweegrichtlijnen.pdf)

Appendix A-1 | Dutch Physical Activity Guidelines

Following international guidelines, the Netherlands has defined guidelines for people to advise them on how much physical activity they should engage in (Gezondheidsraad, 2017). In 2017 these guidelines have been reviewed and restructured to the 'Beweegrichtlijn'. This guideline states the following advice for children aged 5 to 18 and adults, they are visualised in Figure A on the left.

The advice for children, including the target group of this graduation thesis is the following:

Children should engage in at least one hour of of moderate to vigorous physical activity a day. On three days this should include activities to strengthen their muscles and bones and children should prevent themselves from sitting too much. In general applies that the more people engage in physical ctivities, the better (translated based on Gezondheidsraad, 2017, p.4).

Appendix A-2 | Original Ecological Model by Sallis, Cervero, Ascher, Henderson, Kraft, & Kerr, (2006)

This appendix shows the original ecological model of pysical activity behaviour as developed by Sallis et al. (2006, p.301). The model contains variables which are "hypothesized" to influence physical activity behaviour (Sallis et al., 2006, p.303). The findings from the literature review in chapter 3 are used to adapt the model to fit this graduation thesis.

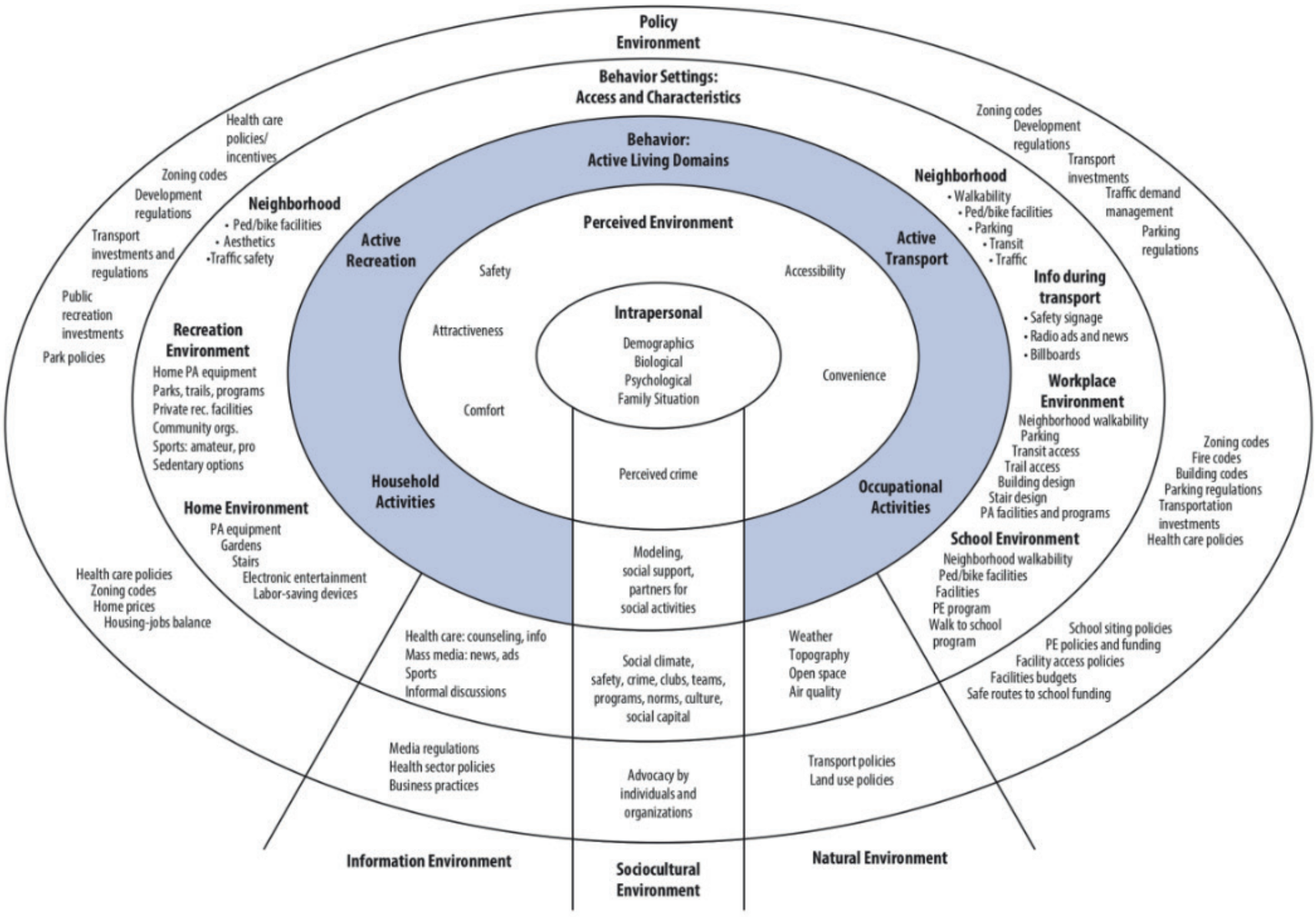

Figure B | Ecological Model of Active Living (Sallis, et al., 2006, p.301)

Appendix A-3 | Figure with Attributes influencing (Adolescent) Physical Activity Behaviour

Only those variables that showed consistent evidence for the given association are taken into account. Variables either showed a positive (+), inconsistent (?) or negative (-) association with (adolescent) physical activity behaviour.

	DEMOGRAPHIC AND BIOLOGICAL VARIABLES	PSYCHOLOGICAL, COGNITIVE, AND EMOTIONAL VARIABLES	BEHAVIOURAL ATTRIBUTES AND SKILLS	SOCIAL AND CULTURAL VARIABLES	PHYSICAL ENVIRONMENT VARIABLES	
					objectively measured environmental variable	perceived environmental variable
+ positive	ethnicity [European American]	achievement / orientation	sensation seeking	sibling physical activity	opportunities to exercise	pedestrian & cyclist safety [adult]
	gender [male]	perceived competence	previous physical activity	direct parental help in physical activity	land-use mix / destinations [OBJ]	equipment and play structures in school environment
		intention	community sports	parental support	residential density [OBJ]	
				support from significant others	access to destinations	
					connectivity of street network	
					proximity of playgrounds and parks	
					availability of recreational facilities	
					aesthetics of the neighbourhood	
					proximity (of green spaces) to home	
? inconsistent		perceived physical appearance / body image	cigarette use	support from peers	parks (access/density/proximity) [OBJ]	recreational facilities (access/density/proximity) [OBJ/PERC]
		self efficacy	meal regularity	subjective norms / social influence	recreational facilities (access/density/proximity) [OBJ/PERC]	walking / cycling facilities [PERC]
		attitudes / outcome expectation		incivilities / disorders [PERC]	street connectivity [OBJ]	traffic speed / volume [PERC]
		likes physical education		cultural differences	month of the year (avg temperature)	traffic safety - unspecified [PERC]
		benfits of physical activity			rural/suburban vs urban (dependent of ethnicity B/W)	access to destinations
		knowledge of exercise / health			size of green space	private home recreation equipment
		motivation			facilities within green space such as sports fields, trails, water features	availability of recreational facilities [adult]
					characteristics of green space fit for target group	availability of recreational facilities
					maintenance of green space	perceived safety [adult]
					presence of physical barriers around green spaces	perceived safety
					amenities such as shade, irrigated lawns, pincnic tables, seating, toilets	presence of physical barriers around green spaces
					seating, water features, toilets [all target groups]	perceived safety - undesirable users; overgrown vegetation; presence of lighting/law enforcement/secluded paths or areas/ surveilance; etc [crime]
					attractiveness of green space - vegetation, wildlife, water features	perceived safety - heavy traffic; other types of users of paths; etc [injury]
					weather / climate	perception of green space characteristics
- inverse	age	depression	sedentary after school		distance to school (school location)	traffic density and speed [adult]
			sedentary on weekend		area depriviation & crime	presence of bike lanes / ease of cycling
					social disorder / stranger danger	roaming dogs
					physical disorder / tidyness of the area	
					unsuitable weather	

Sallis, Prochaska & Taylor (2000)
Assignment AR3U023

Davison & Lawson (2006)
Ding, Sallis, Kerr, Lee & Rosenberg (2011)

Date 06-03-2020
Contact person Ir. J.B.J. Groot Kormelink, secretary HREC
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P.O. Box 5015 2600 GA Delft
The Netherlands

Ethics Approval Application: Urban Design for Physical Activity
Applicant: Romein, Arie

Dear Arie Romein,

It is a pleasure to inform you that your application mentioned above has been approved.

Good luck with your research!

Sincerely,

Dr. Ir. U. Pesch
Chair HREC
Faculty of Technology, Policy and Management

BASIC PLAN 3: 4^5; 3^5; 2^{15}; 16 trials

12345	12345	00000	00001	11111
*****	*****	12345	67890	12345
00000	00000	00000	00000	00000
01123	01121	00001	10111	01110
02231	02211	00010	11011	10011
03312	01112	00011	01100	11101
10111	10111	01100	00110	11011
11032	11012	01101	10001	10101
12320	12120	01110	11101	01000
13203	11201	01111	01010	00110
20222	20222	10100	01011	01101
21301	21101	10101	11100	00011
22013	22011	10110	10000	11110
23130	21110	10111	00111	10000
30333	10111	11000	01101	10110
31210	11210	11001	11010	11000
32102	12102	11010	10110	00101
33021	11021	11011	00001	01011

Figure C | Basic Plan no.3 by Addelman (Steenkamp, 1985, p.147)

Appendix A-5 | Basic Plan by Addelman and Composition of Alternatives

Composition of profiles

As elaborated on in the chapter #, from a total of 1,024 combinations, the basic plans of Addelman (1962, as used in Steenkamp, 1985) make it possible to downsize this amount to sixteen profile sets to be tested in the survey. The figure on the right shows the Basic Plan no.3 by Addelman (Addelman, 1962, in Steenkamp, 1985). This plan is used to define the composition and amount of profiles to develop and show in the survey. The use of attributes with two attribute levels require the use of the columns with 0 and 1 for coding the profiles. The blue box shows the columns that define the composition of the sixteen profiles.

vegetation in the public space [VEGETATION]
-1 = a lot of vegetation and variation
1 = no to little vegetation; little variation

physical barriers [BARRIERS]
-1 = roads around public space that people have to wait for to cross
1 = small and quiet roads only surrounding the public space

opportunities to engage in physical activities [OPPORTUNITIES_PA]
-1 = a lot of different opportunities
1 = little to no opportunities

cycling or walking paths [PATHS]
-1 = cycling and walking paths surrounding and through the public space
1 = cycling and walking paths surrouding the public space only

proximity to home [PROXIMITY]
-1 = less than a 5 min walk
1 = more than a 5 min walk

lighting in the public space [LIGHTING]
-1 = a large share of the space has no lighting present
1 = the entire public space has enough lighting

secluded areas in the public space [SECLUDED_AREAS]
-1 = there are places where you are invisible for the surroundings
1 = from all places you are visible from the surroundings

water features in the public space [WATER]
-1 = absent
1 = present

seating in the public space [SEATING]
-1 = present
1 = absent

public toilets in the public space [TOILETS]
-1 = absent
1 = present

Attributes and coding

The ten spatial attributes are all coded at random. On the right the ten spatial attributes are displayed with their meaning, labeling between [] and coding.
The next two pages show the composition of the sixteen profiles with their corresponding attributes. In the survey respondents each get five times a question with two randomly selected profiles to choose their preferred one. They always have a third answer option “neither one of these”.

profiles >	1	2	3
VEGETATION	veel groen + variatie	veel groen + variatie	veel groen + variatie
BARRIERS	fysieke barrières op je route	fysieke barrières op je route	alleen kleine wegen, niet wachten
OPPORTUNITIES_PA	veel verschillende mogelijkheden	weinig tot geen beweegmogelijkheden	veel verschillende mogelijkheden
PATHS	wandel- en fietspaden rondom én door OR	alleen wandel- en fietspaden rondom OR	alleen wandel- en fietspaden rondom OR
PROXIMITY	huis is dichtbij	huis is dichtbij	huis is ver weg
LIGHTING	grote delen onverlicht	de hele OR is goed verlicht	grote delen onverlicht
SECLUDED_AREAS	er zijn plaatsen waar je onzichtbaar bent vanuit de omgeving	je bent overal goed zichtbaar vanuit de omgeving	je bent overal goed zichtbaar vanuit de omgeving
WATER	afwezig	aanwezig	aanwezig
SEATING	aanwezig	aanwezig	afwezig (grasveld telt hier niet als zitelement)
TOILETS	afwezig	aanwezig	afwezig

4	5	6	7	8
veel groen + variatie	weinig tot geen groen, weinig variatie	weinig tot geen groen, weinig variatie	weinig tot geen groen, weinig variatie	weinig tot geen groen, weinig variatie
alleen kleine wegen, niet wachten	fysieke barrières op je route	fysieke barrières op je route	alleen kleine wegen, niet wachten	alleen kleine wegen, niet wachten
weinig tot geen beweegmogelijkheden	veel verschillende mogelijkheden	weinig tot geen beweegmogelijkheden	veel verschillende mogelijkheden	weinig tot geen beweegmogelijkheden
wandel- en fietspaden rondom én door OR	wandel- en fietspaden rondom én door OR	alleen wandel- en fietspaden rondom OR	alleen wandel- en fietspaden rondom OR	wandel- en fietspaden rondom én door OR
huis is ver weg	huis is dichtbij	huis is dichtbij	huis is ver weg	huis is ver weg
de hele OR is goed verlicht	de hele OR is goed verlicht	grote delen onverlicht	de hele OR is goed verlicht	grote delen onverlicht
er zijn plaatsen waar je onzichtbaar bent vanuit de omgeving	je bent overal goed zichtbaar vanuit de omgeving	er zijn plaatsen waar je onzichtbaar bent vanuit de omgeving	er zijn plaatsen waar je onzichtbaar bent vanuit de omgeving	je bent overal goed zichtbaar vanuit de omgeving
afwezig	afwezig	aanwezig	aanwezig	afwezig
afwezig (grasveld telt hier niet als zitelement)	afwezig (grasveld telt hier niet als zitelement)	afwezig (grasveld telt hier niet als zitelement)	aanwezig	aanwezig
aanwezig	aanwezig	afwezig	aanwezig	afwezig

profiles >	9	10	11
VEGETATION	weinig tot geen groen, weinig variatie	weinig tot geen groen, weinig variatie	weinig tot geen groen, weinig variatie
BARRIERS	fysieke barrières op je route	fysieke barrières op je route	alleen kleine wegen, niet wachten
OPPORTUNITIES_PA	veel verschillende mogelijkheden	weinig tot geen beweegmogelijkheden	veel verschillende mogelijkheden
PATHS	wandel- en fietspaden rondom én door OR	alleen wandel- en fietspaden rondom OR	alleen wandel- en fietspaden rondom OR
PROXIMITY	huis is ver weg	huis is ver weg	huis is dichtbij
LIGHTING	grote delen onverlicht	de hele OR is goed verlicht	grote delen onverlicht
SECLUDED_AREAS	je bent overal goed zichtbaar vanuit de omgeving	er zijn plaatsen waar je onzichtbaar bent vanuit de omgeving	er zijn plaatsen waar je onzichtbaar bent vanuit de omgeving
WATER	aanwezig	afwezig	afwezig
SEATING	aanwezig	aanwezig	afwezig (grasveld telt hier niet als zitelement)
TOILETS	aanwezig	afwezig	aanwezig

12	13	14	15	16
weinig tot geen groen, weinig variatie	veel groen + variatie	veel groen + variatie	veel groen + variatie	veel groen + variatie
alleen kleine wegen, niet wachten	fysieke barrières op je route	fysieke barrières op je route	alleen kleine wegen, niet wachten	alleen kleine wegen, niet wachten
weinig tot geen beweegmogelijkheden	veel verschillende mogelijkheden	weinig tot geen beweegmogelijkheden	veel verschillende mogelijkheden	weinig tot geen beweegmogelijkheden
wandel- en fietspaden rondom én door OR	wandel- en fietspaden rondom én door OR	alleen wandel- en fietspaden rondom OR	alleen wandel- en fietspaden rondom OR	wandel- en fietspaden rondom én door OR
huis is dichtbij	huis is ver weg	huis is ver weg	huis is dichtbij	huis is dichtbij
de hele OR is goed verlicht	de hele OR is goed verlicht	grote delen onverlicht	de hele OR is goed verlicht	grote delen onverlicht
je bent overal goed zichtbaar vanuit de omgeving	er zijn plaatsen waar je onzichtbaar bent vanuit de omgeving	je bent overal goed zichtbaar vanuit de omgeving	je bent overal goed zichtbaar vanuit de omgeving	er zijn plaatsen waar je onzichtbaar bent vanuit de omgeving
aanwezig	aanwezig	afwezig	afwezig	aanwezig
afwezig (grasveld telt hier niet als zitelement)	afwezig (grasveld telt hier niet als zitelement)	afwezig (grasveld telt hier niet als zitelement)	aanwezig	aanwezig
afwezig	afwezig	aanwezig	afwezig	aanwezig

Figure D | Composition of sixteen profiles with attribute levels

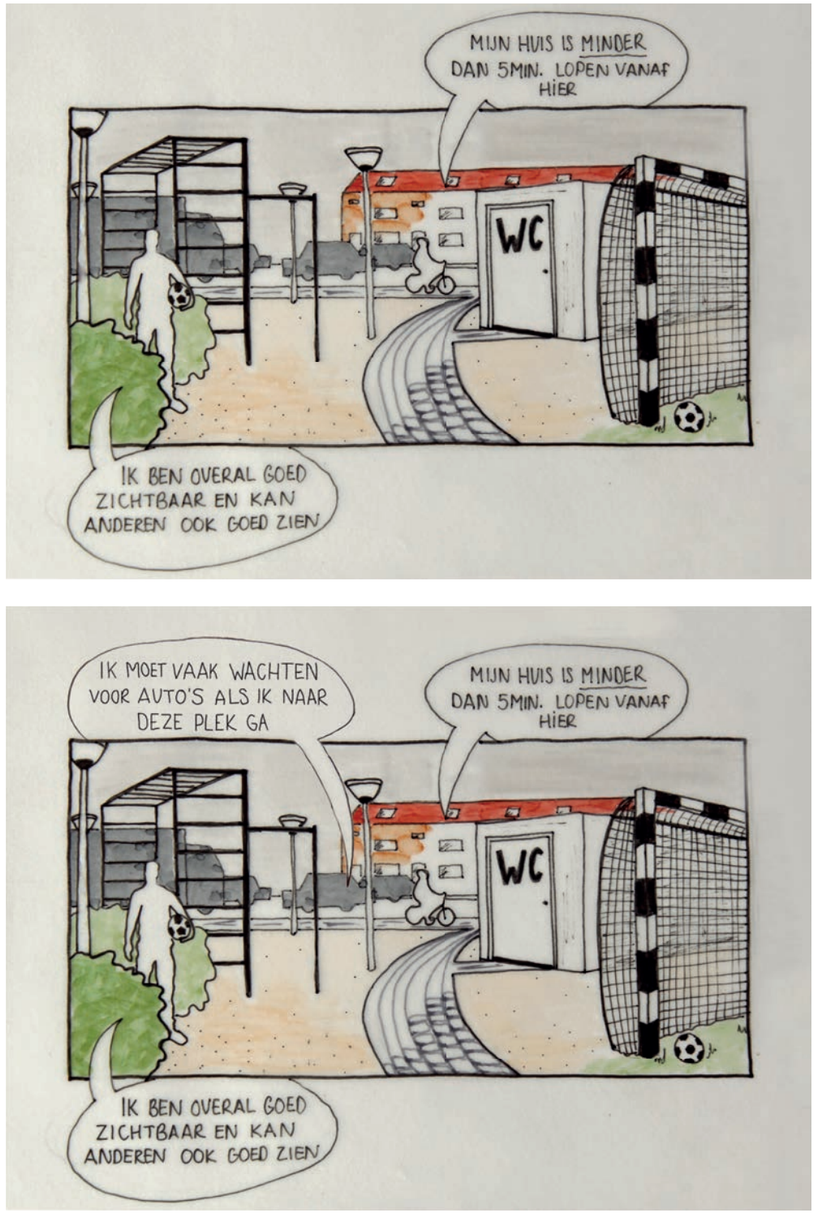


Figure E | Profile in pilot survey (top) and final profile (bottom)

Appendix A-6 | Survey Development

Adaptation survey with feedback

The first version of the survey is tested by eight adolescents outside the spatial context of this thesis. With their feedback the survey and the modeling of the public spaces is adapted for the final distribution.

The interpretation of the images for the conjoint analysis was an important part of the desired feedback. The most remarkable was the difference in interpreting the cars in the profiles. The first version did not have a speech bubble, just the difference in amount and type of cars, see figure # on the right. One respondent considered more cars to be unsafe to play alongside. Another thought it to be *more* safe and to allow her to go there at night, because it would provide for a busier place with more 'eyes on the street'.

This shows the importance of testing, but above all it makes clear that images are open to interpretation, maybe more than text, and that it is crucial to understand and anticipate to misinterpretation. For this survey the solution is found in adding another speech bubble to the profiles, explaining the key message of this attribute, being the barrier one has to wait for.

Another element that came back from the test was the understanding of the terms 'public space' and 'physical activity'. It wasn't always clear what was taken into account, e.g. streets included or excluded. To clarify this from the start, the terms are explained in the beginning of the survey, and are repeated every few questions to kindly remind the repsondents. To not annoy them, the text is made smaller.

To make sure respondents are still focused when arriving at the most important questions, the second version of the survey has been shortened. One question that was partially overlapping other questions has been left out, and one is rephrased to show only three answer options instead of seven. The texts have been reduced to a minimum. For the necessary information on data processing, a link to go to some more information is added.

Appendix A-7 | Survey Questions and Results per Question

INTRODUCTIE

Hoi!

Jouw mening is belangrijk voor mijn afstudeeronderzoek, dus dankjewel dat je deze vragenlijst in wilt vullen!
Het invullen duurt ongeveer tien minuutjes, en kan tot 7 oktober 2020.

Deze vragenlijst is specifiek bedoeld voor jongeren van 12 t/m 17 jaar.

Als je nog vragen hebt, stuur gerust een mailtje naar **s.e.m.vanrijn@student.tudelft.nl**.

Groetjes,
Susanne

ALGEMEEN

1. Hoe oud ben je?
   [slider to answer]

2. Wat ben je?
   - o jongen
   - o meisje
   - o anders

Note: After filling in these first two questions, respondents are forwarded to the right questions regarding the informed consent and data processing. Adolescents from 16 years old can give permission themselves, younger children need consent from their parents. Either the questions for parental consent or for informed consent by the adolescents themselves. The texts and questions aiming at the adolescents themselves are included. The only difference with the texts and questions for parents are the used pronouns. Each of these consent questions is mandatory to continue the survey. An error is displayed when one of the questions is not answered. The survey is aborted when the second question is answered with 'no'.

UITLEG VRAGENLIJST EN TOESTEMMING

Hieronder staat wat meer informatie over de verwerking van de data en jouw privacy. Je kunt hier wel of geen toestemming geven voor een aantal verschillende dingen.

Mocht je vragen hierover hebben, kun je me een mailtje sturen op s.e.m.vanrijn@student.tudelft.nl (je kunt de rest van de vragenlijst dan later invullen als je deze open laat staan). Als je meer over het onderzoek en het proces van de dataverzamling wilt lezen, kun je deze link volgen: Extra informatie onderzoek.

De persoonlijke kenmerken (leeftijd en geslacht) worden alleen gevraagd omdat zij mogelijk invloed hebben op jouw beweeggedrag, en om te controleren of je binnen de doelgroep valt (leeftijd). Verder is de vragenlijst anoniem. Bij het verwerken van alle antwoorden, zullen alleen nog gemiddeldes en percentages worden getoond van leeftijd en geslacht. Alle gegevens worden veilig opgeslagen, en alleen mijn afstudeerbegeleiders en ik kunnen hierbij. Na het afronden van mijn onderzoek kun je de verwerkte antwoorden en mijn rapport terugvinden via https://repository.tudelft.nl/ > 'education'. Let op: dit gaat dus niet om jouw individuele antwoorden, maar om het totaal van alle jongeren die de vragenlijst hebben ingevuld.

Het invullen is natuurlijk vrijwillig en je mag ook altijd besluiten om niet verder te gaan.

- Ik heb de informatie over het onderzoek hierboven gelezen en begrepen. Ik heb mijn vragen kunnen stellen via e-mail en deze zijn nu voldoende beantwoord.

- Ik geef vrijwillig toestemming om mee te doen aan dit onderzoek. Ik begrijp dat ik op elk moment kan kiezen een vraag niet te beantwoorden of kan stoppen, zonder dat ik uit hoef te leggen waarom.

- Ik begrijp dat meedoen aan dit onderzoek inhoudt dat ik een digitale vragenlijst invul.

- Ik begrijp dat de informatie die ik geef door het invullen van de vragenlijst gebruikt wordt in Susanne's afstudeerrapportage en -presentaties.

- Ik geef toestemming om mijn antwoorden op te nemen in de database van onderzoeksresultaten die worden geüpload naar de opslag '4TU.Centre for Research Data', en in de onderwijsopslag van de TU Delft. Let op: als je toestemming geeft, zijn de antwoorden nog steeds niet terug te leiden naar jou persoonlijk.

BEWEGEN EN DE OPENBARE RUIMTE

De volgende vragen gaan over bewegen in de openbare ruimte. Met 'openbare ruimte' worden in deze vragenlijst plekken bedoeld die buiten zijn en waar je altijd naartoe kunt. Voorbeelden hiervan zijn parken, (school-) pleinen en het strand. Straten tellen hierbij niet mee.
Onder bewegen vallen alle activiteiten waarbij je in beweging bent: van sporten tot wandelen naar school en van de gymles tot tikkertje in het park.

3. Hoelang is het lopen naar de openbare ruimte die het dichtst bij jouw huis is waar je kunt bewegen?
   - o minder dan 5 minuten lopen
   - o tussen de 5 en 10 minuten lopen
   - o meer dan 10 minuten lopen
   - o weet ik niet

4. Met wat voor reden ga jij naar openbare ruimtes? Dit mogen dus ook andere plekken zijn dan degene die je bij de vorige vraag in gedachten had.
   Vul bij elke reden in hoe vaak dit voor jou geldt.
   [keuze uit: nooit - soms - een paar keer per maand - een paar keer per week - elke dag]
   (straten tellen weer niet mee)
   - 4.1 om te sporten of te bewegen
   - 4.2 om met vrienden of familie af te spreken
   - 4.3 om naar evenementen te gaan
   - 4.4 om buiten te zijn (voor frisse lucht, zon of om de natuur te beleven)
   - 4.5 om in m'n eentje te ontspannen
   - 4.6 anders, [vul hieronder in]

5. Wat doe jij het liefst in de openbare ruimte om te bewegen?
   [open vraag]

(onthoud: openbare ruimte = plekken die buiten zijn en waar je altijd naartoe kunt, zoals parken, (school-) pleinen en het strand; geen straten
bewegen = alle activiteiten waarbij je in beweging bent: sporten, wandelen naar school, gymles, tikkertje in het park, etc.)

Note: Question number 5 will or will not be shown based on the response of question number 4.1.

GEBRUIK VAN DE OPENBARE RUIMTE

De volgende vragen gaan over wat volgens jou een goede openbare ruimte is om te bewegen. Hieronder zie je eerst een voorbeeldvraag met uitleg, lees en bekijk deze goed, daarna kun je door naar de echte vragen.

VOORBEELD

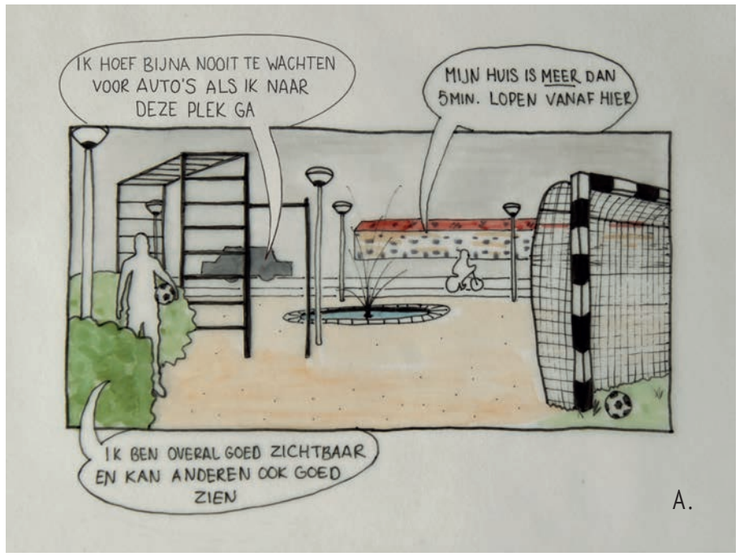
Je krijgt steeds twee plaatjes te zien van een openbare ruimte, zoals hieronder. Het is de bedoeling dat je kiest op welke van die twee plekken je eerder zou gaan bewegen. Er is altijd een derde antwoordmogelijkheid als je ze allebei niet goed genoeg vindt om te gaan bewegen: "Allebei niet".
Je ziet de plaatjes altijd alsof je zelf op die plek bent. Op de plaatjes hieronder kun je zien

dat er van alle kenmerken twee opties zijn: wel of geen verlichting, veel of weinig auto's, veel of weinig groen, etc. Let goed op de verschillen: Alles wat je op de plaatjes ziet, telt mee voor jouw keuze!

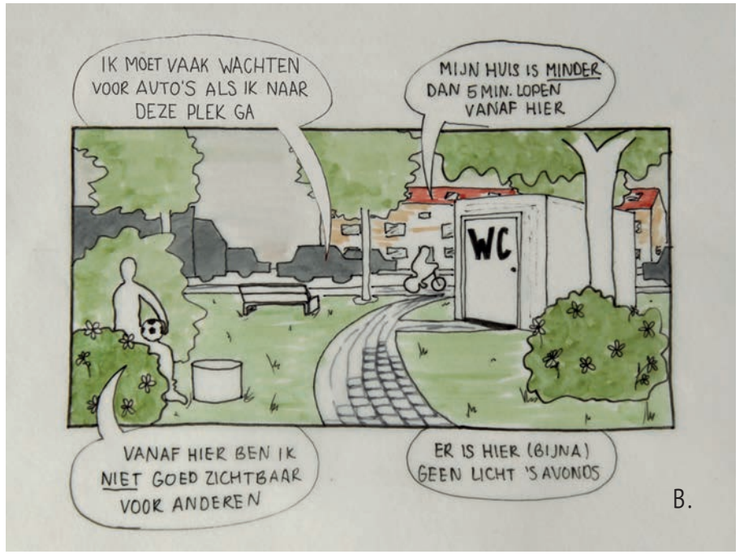
Bij elk plaatje zijn drie of vier tekstballonnetjes toegevoegd. Hierin staan de dingen die je misschien niet zo goed op het plaatje zelf kunt zien. Let op: niet alles wat je op de plaatjes ziet, is dus beschreven in de tekstballonnetjes!

(onthoud:
openbare ruimte = plekken die buiten zijn en waar je altijd naartoe kunt, zoals parken, pleinen en het strand
bewegen = alle activiteiten waarbij je in beweging bent: sporten, wandelen naar school, gymles, tikkertje in het park, etc.)

Waar wil jij eerder gaan bewegen? Kijk rustig naar beide plaatjes en neem goed in je op wat je allemaal ziet.



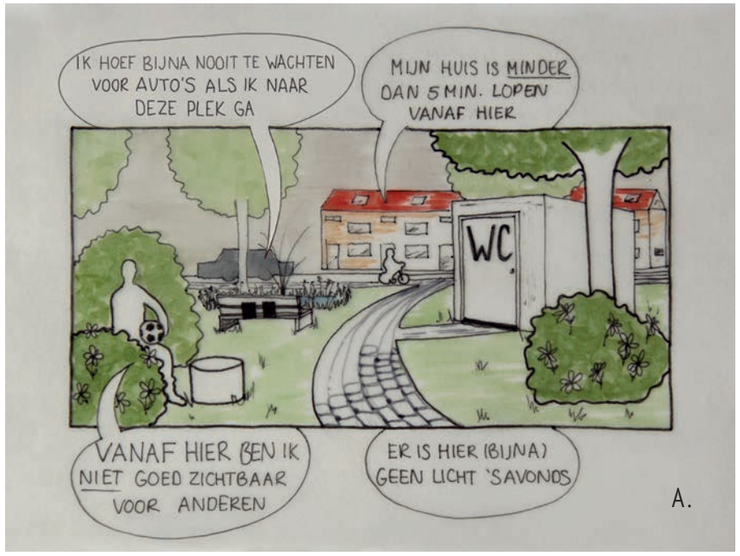
A.



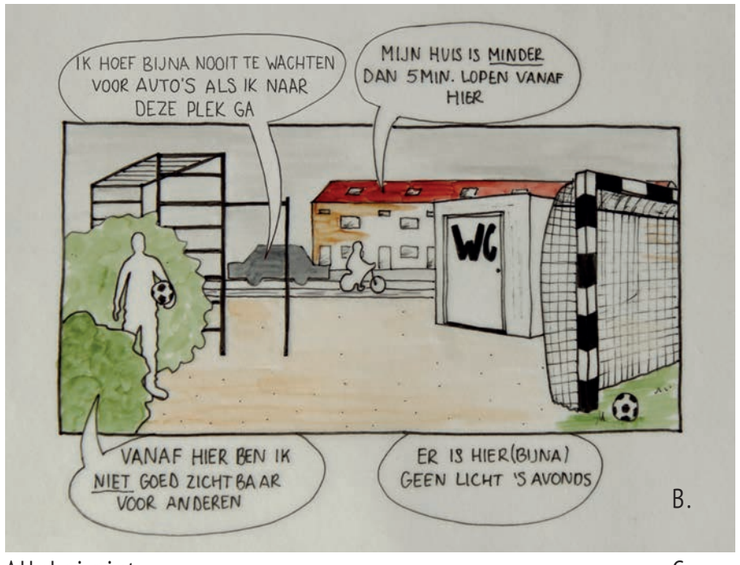
B.

Allebei niet C.

6-10. In welke openbare ruimte wil jij eerder gaan bewegen?
(Je kunt antwoord geven door op het antwoord te klikken)



A.



B.

Allebei niet C.

Note: Respondents get five of these questions with images. The profiles are randomly selected by Qualtrics.

11. What other aspects do you find important to engage in physical activity in public space?
[open question]

BEWEEGGEDRAG

De volgende vragen gaan over hoe jij gedurende een normale week beweegt. Dus voor corona, en niet tijdens de vakanties.

12. Hoeveel uur per week besteed jij gemiddeld aan de volgende activiteiten?
Je mag hierbij alles wat je doet meetellen: je eigen sport, gymles, fietsen naar school, spelen op straat, etc.
- o gymles of school
- o balsporten
- o fitness, turnen of gymnastiek
- o wandelen (inclusief wandelen voor je plezier of bijvoorbeeld naar school)
- o wielersport (inclusief fietsen voor je plezier of bijvoorbeeld naar school)
- o atletiek (inclusief hardlopen)
- o watersport (bijvoorbeeld zwemmen, waterpolo, waterskieën)
- o anders, namelijk [vul hieronder in]

13. In wat voor omgeving doe je deze activiteiten? Als je dit op meerdere plekken doet, vul je de twee in waar je dit het vaakst doet.
- o binnen, bijvoorbeeld in een buurthuis, op sportcomplex of in fitnesscentrum
- o buiten, bijvoorbeeld op een sportcomplex, tennisbaan of in een buitenzwembad
- o buiten, op plekken zoals een (school-) plein of Cruyff Court
- o Buiten in de natuur, op plekken zoals een park, bos of strand
- o thuis (binnen of in de tuin)
- o op straat
- o anders

Note: Each type of activity they answered for in the previous question, except for physical education, is shown this question with the above answer options.

14. Waar zou je deze activiteiten nog meer graag willen doen?
(meerdere antwoorden mogelijk)
- o binnen
- o buiten
- o ik hoef dit nergens anders te doen dan ik nu doe

Note: Each type of activity from question number 12 is shown this question with the above answer options, except for physical education.

BARRIERES OM TE BEWEGEN

15. Wat houdt jou op dit moment tegen om meer in de openbare ruimte te bewegen? Kies de drie stellingen die voor jou het meest belangrijk zijn en zet deze op volgorde. Bij de stelling die jou het meeste tegenhoudt, vul je een 1 in, bij degene die jou daarna het meeste tegenhoudt een 2, en zo verder. Als je vindt dat er maar 2 stellingen bij jou passen, vul je alleen 1 en 2 in.
    - o ik heb te weinig tijd
    - o ik heb geen zin of doe liever iets anders
    - o ik beweeg al voldoende
    - o er is geen buitenruimte in de buurt die hier goed voor is
    - o ik beweeg en sport liever binnen
    - o anders, namelijk [vul hieronder in]

TOT SLOT

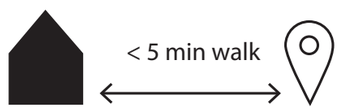
16. Heb je nog andere opmerkingen?

Dankjewel voor het invullen, je hebt me hier enorm mee geholpen!
Ik wil graag zo veel mogelijk jongeren die in Westland wonen bereiken, dus als je deze vragenlijst wilt delen, zou dat fantastisch zijn!

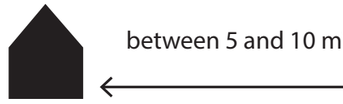
Als je nog vragen hebt over de vragenlijst of het onderzoek, stuur me gerust een mailtje op: s.e.m.vanrijn@student.tudelft.nl.

For questions that are not elaborated on in the report, results are shown here.

Q3 | How long does it take to walk from home to the closest public space where you can engage in physical activity? [PS_proximity]



65% [42]

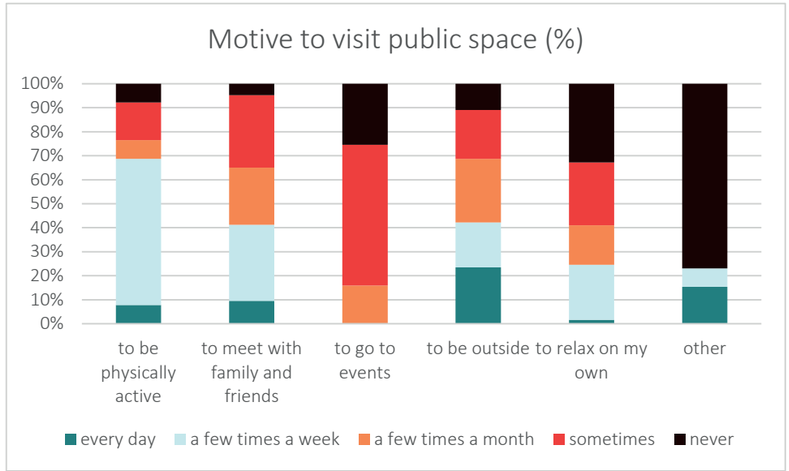


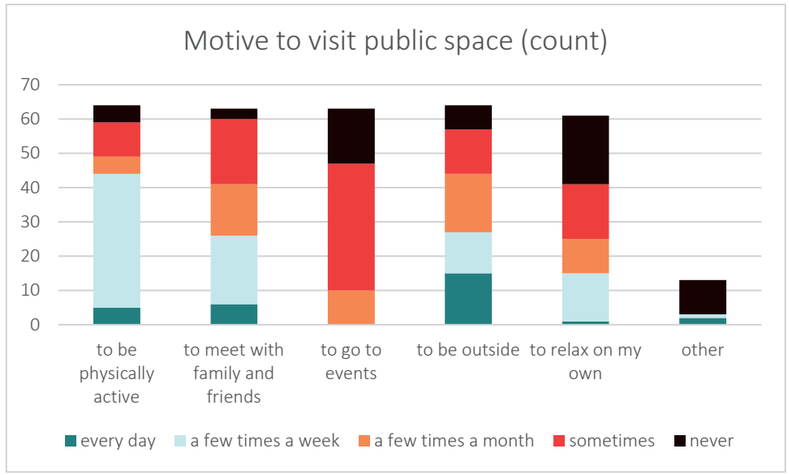
22% [14]

11% [7]

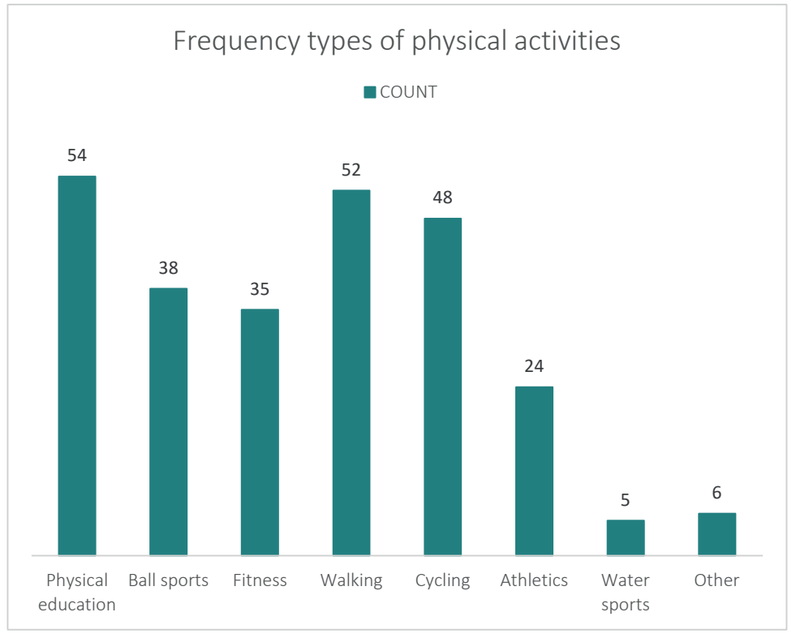
3% [2]

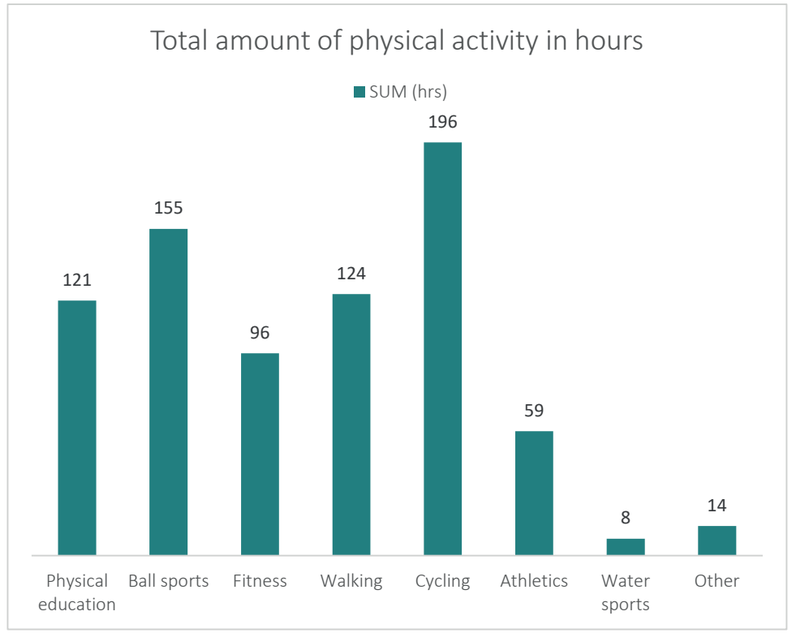
Q4 | Why do you visit public space? [PS_motives]





Q6 | How many hours do you spend doing physical activities per week? [in hours per week per activity] [PA_DUR-TYPE]

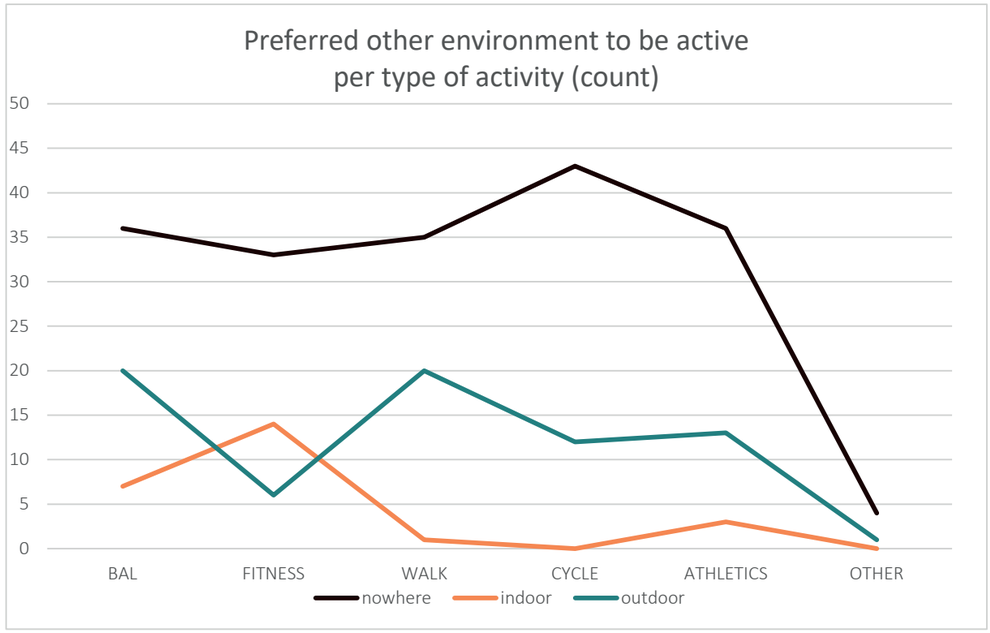


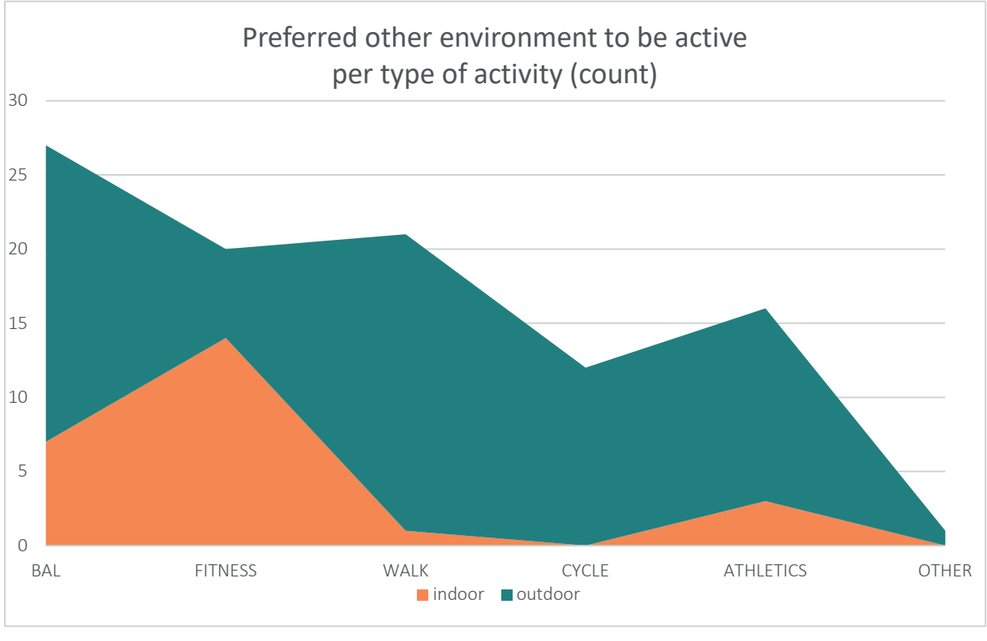


Q6 | How many hours do you spend doing physical activities per week? [in hours per week per activity] [PA_DUR-TYPE]

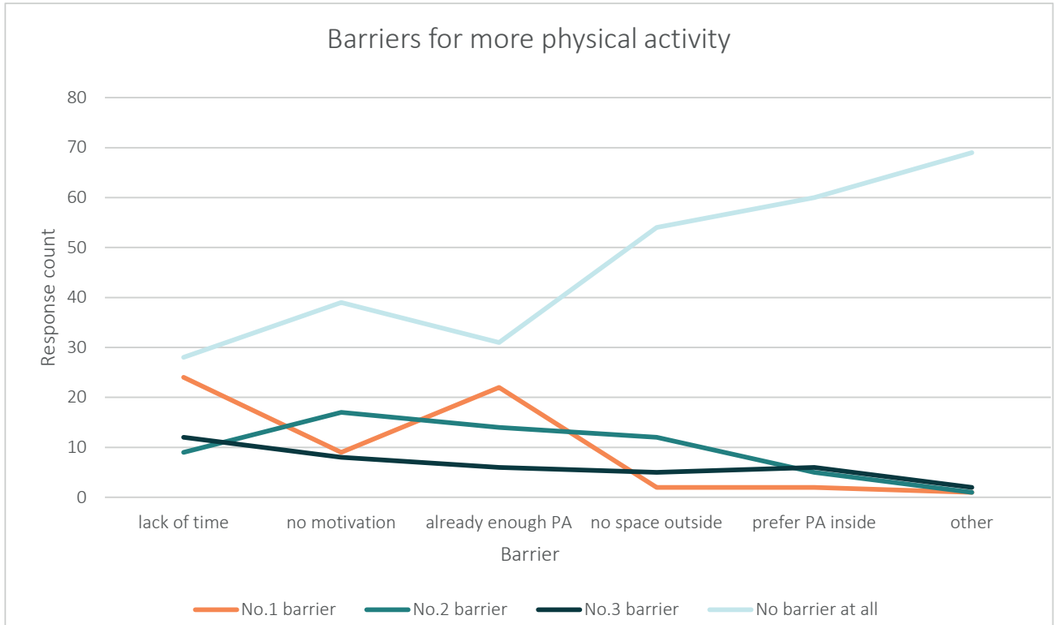
Apart from that Sallis et al. (2000) show gender to be positively associated with adolescent physical activity behaviour. They state that boys are in general more active than girls (Sallis et al., 2000). The above figure shows the amount of physical activity in hours for boys (=1) and girls (=2). The average of physical activity is similar for both genders. It displays that apart from the one extreme for girls, the amount of physical activity is somewhat less dispersed than for boys. However the extreme low amounts are lower for the boys.

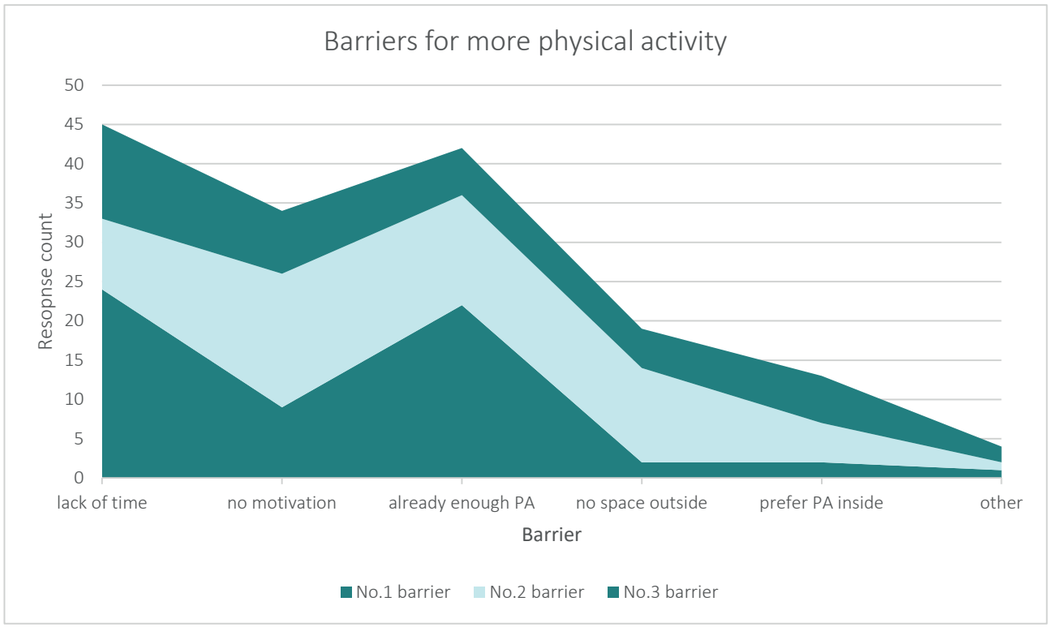
Q7 | Where would you like to do these activites more often? [PA_ENVTYPE_WISH]





Q8 | What is withoulding you to do more physical activities than you do now? [PA_PS_BARRIERS]





Appendix A-8 | Model specification in PandasBiogeme

PandasBiogeme is used to specify the model to estimate the relative importance of the ten spatial attributes. Below is the model specification of the basic model as shown in chapter five. Four other models are estimated with the same data to find out if there are major differences between sub groups of the respondents. They are all based on this basic model and are specifically to understand the following sub groups: (1) girls; (2) boys; (3) adolescents aged 12-14; and (4) adolescents aged 15-17.

No choice alternative

Haaijer, Kamakura and Wagner (2001) give two grounds for respondents to select the no choice alternative of a choice set. The one that applies here is the one where respondents have no explicit preference for one of the displayed alternatives over the other (Haaijer et al., 2001). The survey used in this thesis has specifically stated the third option "neither one of these alternatives" which corresponds with the above reason as explained by Haaijer et al. (2001). They suggest "a Multinomial Logit model, with a no-choice constant, ... since it treats all alternatives equally" (Haaijer et al., 2001, p.105). In the modelspecification the no choice alternative is included by adding a utility function, V0. This utility function only consists of a parameter ASC_P0, as no choice also means that there are no attributes attached. See input lines 15 and 16 in de model specification. ASC_P0 has a fixed value for estimation purposes. This means that all other parameters of the alternative (ASC_P1 to ASC_P16) have a value as compared to the no choice alternative.


```
#File 261020_finalestimate \
#:author: Susanne van Rijn \
#:date: October 26, 2020 \
#Model to estimate the relative importance of ten spatial attributes of
public space to use the space for physical activity by adolescents. \
#Based on final survey results with 304 observations \
#25 parameters to be estimated, 17 utilitiyfunctions with 16
alternatives and a 'no choice'\
#Model type: multinomial logit regression analysis; logit \
```

Importing the packages

```
In[1]:     import pandas as pd
           import biogeme.database as db
           import biogeme.biogeme as bio
           import biogeme.models as models
           import biogeme.version as ver
           from biogeme.expressions import Beta
In [2]:    import numpy as np
```

Read the data

```
# \; in below function is to separate columns with ;\

In [3]:    df = pd.read_csv('D:\\empoli\\repos\\SurveyDataTransformer\\

In [4]:    database = db.Database('D:\\empoli\\repos\\
           SurveyDataTransformer\\Testdata\\231020_finalresults.csv_
           result.csv', df)

# print(df) gives 330 rows and 243 columns of data \


# use the isnan function to find NaN values in datafile, those cannot be
read by Biogeme \

In [5]:    import math
In [6]:    print(math.isnan(float('nan')))
Out [1]:   True

# the next two commands check if 1: there are NaN values left in the
datafile and if True 2: how many

In [7]:    df.isnull()values.any()
Out [2]:   False
In [8]:    df.isnull().sum().sum()
Out [3]:   0
```

Define names of variables as python variables

```
In [9]:    globals().update(database.variables)
```

Remove some observations

```
In [10]:   database.getSampleSize()
Out [4]:   335

# this command excludes all observations from the model that come from
unfinished surveys

In [11]:   exclude = (FINISHED != 1)
In [12]:   database.remove(exclude)
In [13]:   database.getSampleSize()
Out[5]:    309

# this print command shows if all respondents are within the target group
of 12 to 17 year olds (Yes) \

In [14]:   df.AGE_1.describe()
Out[6]:    count    304.000000
           mean      15.394737
           std        1.561323
           min       12.000000
           25%       14.000000
           50%       16.000000
           75%       17.000000
           max       17.000000
           Name: AGE_1, dtype: float64
```


Model specification

Parameters to be estimated

```
# for every alternative (profile) an ASC is estimated, for ASC_P1 the
value is fixed to estimate the others as compared to this one

#For every attribute (ten in total) a Beta is estimated

In [15]:   ASC_P0 = Beta('ASC_P0', 0, None, None, 1)
           ASC_P1 = Beta('ASC_P1', 0, None, None, 0)
           ASC_P2 = Beta('ASC_P2', 0, None, None, 0)
           ASC_P3 = Beta('ASC_P3', 0, None, None, 0)
           ASC_P4 = Beta('ASC_P4', 0, None, None, 0)
           ASC_P5 = Beta('ASC_P5', 0, None, None, 0)
           ASC_P6 = Beta('ASC_P6', 0, None, None, 0)
           ASC_P7 = Beta('ASC_P7', 0, None, None, 0)
           ASC_P8 = Beta('ASC_P8', 0, None, None, 0)
           ASC_P9 = Beta('ASC_P9', 0, None, None, 0)
           ASC_P10 = Beta('ASC_P10', 0, None, None, 0)
           ASC_P11 = Beta('ASC_P11', 0, None, None, 0)
           ASC_P12 = Beta('ASC_P12', 0, None, None, 0)
           ASC_P13 = Beta('ASC_P13', 0, None, None, 0)
           ASC_P14 = Beta('ASC_P14', 0, None, None, 0)
           ASC_P15 = Beta('ASC_P15', 0, None, None, 0)
           ASC_P16 = Beta('ASC_P16', 0, None, None, 0)

           B_VEGETATION = Beta('B_VEGETATION', 0, None, None, 0)
           B_BARRIERS = Beta('B_BARRIERS', 0, None, None, 0)
           B_OPPORTUNITIES_PA = Beta('B_OPPORTUNITIES_PA',0,None,None,0)
           B_PATHS = Beta('B_PATHS', 0, None, None, 0)
           B_PROXIMITY = Beta('B_PROXIMITY', 0, None, None, 0)
           B_LIGHTING = Beta('B_LIGHTING', 0, None, None, 0)
           B_SECLUDED_AREAS = Beta('B_SECLUDED_AREAS', 0, None, None, 0)
           B_WATER = Beta('B_WATER', 0, None, None, 0)
           B_SEATING = Beta('B_SEATING', 0, None, None, 0)
           B_TOILETS = Beta('B_TOILETS', 0, None, None, 0)
```

Specification of the utility functions

```
# Utility function for the 'no choice alternative'

In [16]:   V0 = ASC_P0
```

```
#16 Utility functions, one for each alternative

In [17]:   V1 = ASC_P1 + \
           B_VEGETATION * VEGETATION_1 + \
           B_BARRIERS * BARRIERS_1 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_1 + \
           B_PATHS * PATHS_1 + \
           B_PROXIMITY * PROXIMITY_1 + \
           B_LIGHTING * LIGHTING_1 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_1 + \
           B_WATER * WATER_1 + \
           B_SEATING * SEATING_1 + \
           B_TOILETS * TOILETS_1

In [18]:   V2 = ASC_P2 + \
           B_VEGETATION * VEGETATION_2 + \
           B_BARRIERS * BARRIERS_2 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_2 + \
           B_PATHS * PATHS_2 + \
           B_PROXIMITY * PROXIMITY_2 + \
           B_LIGHTING * LIGHTING_2 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_2 + \
           B_WATER * WATER_2 + \
           B_SEATING * SEATING_2 + \
           B_TOILETS * TOILETS_2

In [19]:   V3 = ASC_P3 + \
           B_VEGETATION * VEGETATION_3 + \
           B_BARRIERS * BARRIERS_3 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_3 + \
           B_PATHS * PATHS_3 + \
           B_PROXIMITY * PROXIMITY_3 + \
           B_LIGHTING * LIGHTING_3 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_3 + \
           B_WATER * WATER_3 + \
           B_SEATING * SEATING_3 + \
           B_TOILETS * TOILETS_3

In [20]:   V4 = ASC_P4 + \
           B_VEGETATION * VEGETATION_4 + \
           B_BARRIERS * BARRIERS_4 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_4 + \
           B_PATHS * PATHS_4 + \
           B_PROXIMITY * PROXIMITY_4 + \
           B_LIGHTING * LIGHTING_4 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_4 + \
           B_WATER * WATER_4 + \
           B_SEATING * SEATING_4 + \
           B_TOILETS * TOILETS_4
```



```
In [21]:   V5 = ASC_P5 + \
           B_VEGETATION * VEGETATION_5 + \
           B_BARRIERS * BARRIERS_5 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_5 + \
           B_PATHS * PATHS_5 + \
           B_PROXIMITY * PROXIMITY_5 + \
           B_LIGHTING * LIGHTING_5 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_5 + \
           B_WATER * WATER_5 + \
           B_SEATING * SEATING_5 + \
           B_TOILETS * TOILETS_5

In [22]:   V6 = ASC_P6 + \
           B_VEGETATION * VEGETATION_6 + \
           B_BARRIERS * BARRIERS_6 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_6 + \
           B_PATHS * PATHS_6 + \
           B_PROXIMITY * PROXIMITY_6 + \
           B_LIGHTING * LIGHTING_6 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_6 + \
           B_WATER * WATER_6 + \
           B_SEATING * SEATING_6 + \
           B_TOILETS * TOILETS_6

In [23]:   V7 = ASC_P7 + \
           B_VEGETATION * VEGETATION_7 + \
           B_BARRIERS * BARRIERS_7 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_7 + \
           B_PATHS * PATHS_7 + \
           B_PROXIMITY * PROXIMITY_7 + \
           B_LIGHTING * LIGHTING_7 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_7 + \
           B_WATER * WATER_7 + \
           B_SEATING * SEATING_7 + \
           B_TOILETS * TOILETS_7

In [24]:   V8 = ASC_P8 + \
           B_VEGETATION * VEGETATION_8 + \
           B_BARRIERS * BARRIERS_8 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_8 + \
           B_PATHS * PATHS_8 + \
           B_PROXIMITY * PROXIMITY_8 + \
           B_LIGHTING * LIGHTING_8 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_8 + \
           B_WATER * WATER_8 + \
           B_SEATING * SEATING_8 + \
           B_TOILETS * TOILETS_8
```

```
In [25]:   V9 = ASC_P9 + \
           B_VEGETATION * VEGETATION_9 + \
           B_BARRIERS * BARRIERS_9 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_9 + \
           B_PATHS * PATHS_9 + \
           B_PROXIMITY * PROXIMITY_9 + \
           B_LIGHTING * LIGHTING_9 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_9 + \
           B_WATER * WATER_9 + \
           B_SEATING * SEATING_9 + \
           B_TOILETS * TOILETS_9

In [26]:   V10 = ASC_P10 + \
           B_VEGETATION * VEGETATION_10 + \
           B_BARRIERS * BARRIERS_10 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_10 + \
           B_PATHS * PATHS_10 + \
           B_PROXIMITY * PROXIMITY_10 + \
           B_LIGHTING * LIGHTING_10 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_10 + \
           B_WATER * WATER_10 + \
           B_SEATING * SEATING_10 + \
           B_TOILETS * TOILETS_10

In [27]:   V11 = ASC_P11 + \
           B_VEGETATION * VEGETATION_11 + \
           B_BARRIERS * BARRIERS_11 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_11 + \
           B_PATHS * PATHS_11 + \
           B_PROXIMITY * PROXIMITY_11 + \
           B_LIGHTING * LIGHTING_11 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_11 + \
           B_WATER * WATER_11 + \
           B_SEATING * SEATING_11 + \
           B_TOILETS * TOILETS_11

In [28]:   V12 = ASC_P12 + \
           B_VEGETATION * VEGETATION_12 + \
           B_BARRIERS * BARRIERS_12 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_12 + \
           B_PATHS * PATHS_12 + \
           B_PROXIMITY * PROXIMITY_12 + \
           B_LIGHTING * LIGHTING_12 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_12 + \
           B_WATER * WATER_12 + \
           B_SEATING * SEATING_12 + \
           B_TOILETS * TOILETS_12
```



```
In [29]:   V13 = ASC_P13 + \
           B_VEGETATION * VEGETATION_13 + \
           B_BARRIERS * BARRIERS_13 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_13 + \
           B_PATHS * PATHS_13 + \
           B_PROXIMITY * PROXIMITY_13 + \
           B_LIGHTING * LIGHTING_13 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_13 + \
           B_WATER * WATER_13 + \
           B_SEATING * SEATING_13 + \
           B_TOILETS * TOILETS_13

In [30]:   V14 = ASC_P14 + \
           B_VEGETATION * VEGETATION_14 + \
           B_BARRIERS * BARRIERS_14 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_14 + \
           B_PATHS * PATHS_14 + \
           B_PROXIMITY * PROXIMITY_14 + \
           B_LIGHTING * LIGHTING_14 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_14 + \
           B_WATER * WATER_14 + \
           B_SEATING * SEATING_14 + \
           B_TOILETS * TOILETS_14

In [31]:   V15 = ASC_P15 + \
           B_VEGETATION * VEGETATION_15 + \
           B_BARRIERS * BARRIERS_15 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_15 + \
           B_PATHS * PATHS_15 + \
           B_PROXIMITY * PROXIMITY_15 + \
           B_LIGHTING * LIGHTING_15 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_15 + \
           B_WATER * WATER_15 + \
           B_SEATING * SEATING_15 + \
           B_TOILETS * TOILETS_15

In [32]:   V16 = ASC_P16 + \
           B_VEGETATION * VEGETATION_16 + \
           B_BARRIERS * BARRIERS_16 + \
           B_OPPORTUNITIES_PA * OPPORTUNITIES_PA_16 + \
           B_PATHS * PATHS_16 + \
           B_PROXIMITY * PROXIMITY_16 + \
           B_LIGHTING * LIGHTING_16 + \
           B_SECLUDED_AREAS * SECLUDED_AREAS_16 + \
           B_WATER * WATER_16 + \
           B_SEATING * SEATING_16 + \
           B_TOILETS * TOILETS_16
```

```
# command to estimate the model: logprob = models.loglogit(V,av,i) \
# V = utilitiy function \
# av = availability of a specific alternative (None, if all alternatives
are available for all respondents) \
#i = id of the alternative for which the probability must be calculated \

#dictionary to extract the different utility functions \
In [33]:   V = {0: V0, 1: V1, 2: V2, 3: V3, 4: V4,
            5: V5, 6: V6, 7: V7, 8: V8,
            9: V9, 10: V10, 11: V11, 12: V12,
            13: V13, 14: V14, 15: V15, 16: V16}

#dictionary to extract the different availabilities \
In [34]:   av = {0: 1, 1: AV1, 2: AV2, 3: AV3, 4: AV4,
                 5: AV5, 6: AV6, 7: AV7, 8: AV8,
                 9: AV9, 10: AV10, 11: AV11, 12: AV12,
                 13: AV13, 14: AV14, 15: AV15, 16: AV16}

# variable that gives the number of the alternative to calculate is called
CHOICE, retrieved from dataframe \
In [35]:   logprob = models.loglogit(V, av, CHOICE)
```

Biogeme

```
In [36]:   biogeme = bio.BIOGEME(database, logprob)
           biogeme.modelName = '261020_finalestimate'
```

Running the estimation

```
In [37]:   results = biogeme.estimate()
In [38]:   pandasResults = results.getEstimatedParameters()
           pandasResults
```

```
Out [7]:   (see table next page)
```

Figure F | Estimated parameters from PandasBiogeme - basic model

	Value	Std err	t-test	p-value	Rob. Std err	Rob. t-test	Rob. p-value
ASC_P10	1.291958	0.280044	4.613404	0.000003961	0.274535	4.70599	0.000002526
ASC_P11	1.28773	0.264792	4.863182	0.000001155	0.262676	4.90235	0.000000947
ASC_P12	1.900512	0.348824	5.448347	0.000000051	0.353221	5.380514	0.000000074
ASC_P13	0.939541	0.261298	3.595672	0.000323555	0.258078	3.640528	0.000272080
ASC_P14	1.557089	0.293575	5.303885	0.000000113	0.290813	5.354255	0.000000086
ASC_P15	1.224159	0.281408	4.350117	0.000013607	0.286838	4.267774	0.000019743
ASC_P16	1.007041	0.262318	3.839014	0.000123529	0.25052	4.019803	0.000058247
ASC_P2	1.607727	0.308035	5.219292	0.000000180	0.309351	5.197093	0.000000202
ASC_P3	1.738449	0.306456	5.672749	0.000000014	0.313196	5.550674	0.000000028
ASC_P4	1.827002	0.302857	6.032554	0.000000002	0.310007	5.893416	0.000000004
ASC_P5	1.359274	0.261335	5.201263	0.000000198	0.259267	5.242765	0.000000158
ASC_P6	1.388911	0.281711	4.930267	0.000000821	0.292115	4.754674	0.000001988
ASC_P7	1.900389	0.349319	5.440263	0.000000053	0.349692	5.434468	0.000000055
ASC_P8	1.215625	0.276262	4.400253	0.000010812	0.272938	4.453856	0.000008434
ASC_P9	1.4253	0.272851	5.223738	0.000000175	0.273246	5.216187	0.000000183
B_BARRIERS	0.111839	0.0903	1.238529	0.215520100	0.091998	1.215664	0.224112900
B_LIGHTING	0.011151	0.089695	0.124318	0.901063800	0.087409	0.127569	0.898489900
B_OPPORTUNITIES_PA	-0.498245	0.090322	-5.516337	0.000000035	0.092667	-5.376704	0.000000076
B_PATHS	-0.09715	0.088862	-1.093273	0.274274100	0.091512	-1.061612	0.288411800
B_PROXIMITY	-0.29927	0.090059	-3.323053	0.000890381	0.091762	-3.261367	0.001108765
B_SEATING	-0.092959	0.087817	-1.058553	0.289803600	0.086739	-1.071713	0.283849100
B_SECLUDED_AREAS	-0.033704	0.088032	-0.382866	0.701819000	0.089212	-0.3778	0.705579500
B_TOILETS	-0.14687	0.086595	-1.696054	0.089875690	0.084575	-1.736551	0.082466450
B_VEGETATION	-0.550576	0.086067	-6.397094	0.000000000	0.086359	-6.375435	0.000000000
B_WATER	-0.274236	0.085597	-3.203791	0.001356311	0.080379	-3.411784	0.000645392

```
#the command below ensures that the values of each beta-coefficient are
included in the utility functions

In [39]:   ASC_P1 = results.getBetaValues(['ASC_P1']).get('ASC_P1')
           ASC_P10 = results.getBetaValues(['ASC_P10']).get('ASC_P10')
           ASC_P11 = results.getBetaValues(['ASC_P11']).get('ASC_P11')
           ASC_P12 = results.getBetaValues(['ASC_P12']).get('ASC_P12')
           ASC_P13 = results.getBetaValues(['ASC_P13']).get('ASC_P13')
           ASC_P14 = results.getBetaValues(['ASC_P14']).get('ASC_P14')
           ASC_P15 = results.getBetaValues(['ASC_P15']).get('ASC_P15')
           ASC_P16 = results.getBetaValues(['ASC_P16']).get('ASC_P16')
           ASC_P2 = results.getBetaValues(['ASC_P2']).get('ASC_P2')
           ASC_P3 = results.getBetaValues(['ASC_P3']).get('ASC_P3')
           ASC_P4 = results.getBetaValues(['ASC_P4']).get('ASC_P4')
           ASC_P5 = results.getBetaValues(['ASC_P5']).get('ASC_P5')
           ASC_P6 = results.getBetaValues(['ASC_P6']).get('ASC_P6')
           ASC_P7 = results.getBetaValues(['ASC_P7']).get('ASC_P7')
           ASC_P8 = results.getBetaValues(['ASC_P8']).get('ASC_P8')
           ASC_P9 = results.getBetaValues(['ASC_P9']).get('ASC_P9')
           B_BARRIERS = results.getBetaValues(['B_BARRIERS']).get('B_
                BARRIERS')
           B_LIGHTING = results.getBetaValues(['B_LIGHTING']).get('B_
                LIGHTING')
           B_OPPORTUNITIES_PA = results.getBetaValues(['B_OPPORTUNITIES_
                PA']).get('B_OPPORTUNITIES_PA')
           B_PATHS = results.getBetaValues(['B_PATHS']).get('B_PATHS')
           B_PROXIMITY = results.getBetaValues(['B_PROXIMITY']).get('B_
                PROXIMITY')
           B_SEATING = results.getBetaValues(['B_SEATING']).get('B_
                SEATING')
           B_SECLUDED_AREAS = results.getBetaValues(['B_SECLUDED_
           AREAS']).
                get('B_SECLUDED_AREAS')
           B_TOILETS = results.getBetaValues(['B_TOILETS']).get('B_
                TOILETS')
           B_VEGETATION = results.getBetaValues(['B_VEGETATION']).get('B_
                VEGETATION')
           B_WATER = results.getBetaValues(['B_WATER']).get('B_WATER')
```



```
#the below lines calculate the utility function for eacht alternative with
the estimated coefficients
#the command df.VEGETATION_1[0] gives the value of the attribute level (1
or -1) for the attribute Vegetation at the first (0) row

In [40]:   V1 = ASC_P1 + \
           B_VEGETATION * df.VEGETATION_1[0] + \
           B_BARRIERS * df.BARRIERS_1[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_1[0] + \
           B_PATHS * df.PATHS_1[0] + \
           B_PROXIMITY * df.PROXIMITY_1[0] + \
           B_LIGHTING * df.LIGHTING_1[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_1[0] + \
           B_WATER * df.WATER_1[0] + \
           B_SEATING * df.SEATING_1[0] + \
           B_TOILETS * df.TOILETS_1[0]
In [41]:   V1
Out [8]:   1.9381570493912663

In [42]:   V2 = ASC_P2 + \
           B_VEGETATION * df.VEGETATION_2[0] + \
           B_BARRIERS * df.BARRIERS_2[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_2[0] + \
           B_PATHS * df.PATHS_2[0] + \
           B_PROXIMITY * df.PROXIMITY_2[0] + \
           B_LIGHTING * df.LIGHTING_2[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_2[0] + \
           B_WATER * df.WATER_2[0] + \
           B_SEATING * df.SEATING_2[0] + \
           B_TOILETS * df.TOILETS_2[0]
[In 43]:   V2
[Out 9]:   1.3988210221952013

[In 44]:   V3 = ASC_P3 + \
           B_VEGETATION * df.VEGETATION_3[0] + \
           B_BARRIERS * df.BARRIERS_3[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_3[0] + \
           B_PATHS * df.PATHS_3[0] + \
           B_PROXIMITY * df.PROXIMITY_3[0] + \
           B_LIGHTING * df.LIGHTING_3[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_3[0] + \
           B_WATER * df.WATER_3[0] + \
           B_SEATING * df.SEATING_3[0] + \
           B_TOILETS * df.TOILETS_3[0]
[In 45]:   V3
[Out 10]:  2.2979584957123023
```

```
[In 46]:   V4 = ASC_P4 + \
           B_VEGETATION * df.VEGETATION_4[0] + \
           B_BARRIERS * df.BARRIERS_4[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_4[0] + \
           B_PATHS * df.PATHS_4[0] + \
           B_PROXIMITY * df.PROXIMITY_4[0] + \
           B_LIGHTING * df.LIGHTING_4[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_4[0] + \
           B_WATER * df.WATER_4[0] + \
           B_SEATING * df.SEATING_4[0] + \
           B_TOILETS * df.TOILETS_4[0]
[In 47]:   V4
[Out 11]:  1.8799742095027046

[In 49]:   V5 = ASC_P5 + \
           B_VEGETATION * df.VEGETATION_5[0] + \
           B_BARRIERS * df.BARRIERS_5[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_5[0] + \
           B_PATHS * df.PATHS_5[0] + \
           B_PROXIMITY * df.PROXIMITY_5[0] + \
           B_LIGHTING * df.LIGHTING_5[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_5[0] + \
           B_WATER * df.WATER_5[0] + \
           B_SEATING * df.SEATING_5[0] + \
           B_TOILETS * df.TOILETS_5[0]
[In 50]:   V5
[Out 12]:  1.621321595622564

[In 51]:   V6 = ASC_P6 + \
           B_VEGETATION * df.VEGETATION_6[0] + \
           B_BARRIERS * df.BARRIERS_6[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_6[0] + \
           B_PATHS * df.PATHS_6[0] + \
           B_PROXIMITY * df.PROXIMITY_6[0] + \
           B_LIGHTING * df.LIGHTING_6[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_6[0] + \
           B_WATER * df.WATER_6[0] + \
           B_SEATING * df.SEATING_6[0] + \
           B_TOILETS * df.TOILETS_6[0]
[In 52]:   V6
[Out 13]:  0.34402797748828523

[In 53]:   V7 = ASC_P7 + \
           B_VEGETATION * df.VEGETATION_7[0] + \
           B_BARRIERS * df.BARRIERS_7[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_7[0] + \
           B_PATHS * df.PATHS_7[0] + \
           B_PROXIMITY * df.PROXIMITY_7[0] + \
```



```
           B_LIGHTING * df.LIGHTING_7[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_7[0] + \
           B_WATER * df.WATER_7[0] + \
           B_SEATING * df.SEATING_7[0] + \
           B_TOILETS * df.TOILETS_7[0]
[In 54]:   V7
[Out 14]:  1.3595997190862181

[In 55]:   V8 = ASC_P8 + \
           B_VEGETATION * df.VEGETATION_8[0] + \
           B_BARRIERS * df.BARRIERS_8[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_8[0] + \
           B_PATHS * df.PATHS_8[0] + \
           B_PROXIMITY * df.PROXIMITY_8[0] + \
           B_LIGHTING * df.LIGHTING_8[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_8[0] + \
           B_WATER * df.WATER_8[0] + \
           B_SEATING * df.SEATING_8[0] + \
           B_TOILETS * df.TOILETS_8[0]
[In 56]:   V8
[Out 15]:  0.4964738988746719

[In 57]:   V9 = ASC_P9 + \
           B_VEGETATION * df.VEGETATION_9[0] + \
           B_BARRIERS * df.BARRIERS_9[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_9[0] + \
           B_PATHS * df.PATHS_9[0] + \
           B_PROXIMITY * df.PROXIMITY_9[0] + \
           B_LIGHTING * df.LIGHTING_9[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_9[0] + \
           B_WATER * df.WATER_9[0] + \
           B_SEATING * df.SEATING_9[0] + \
           B_TOILETS * df.TOILETS_9[0]
[In 58]:   V9
[Out 16]:  0.69438928760916

[In 59]:   V10 = ASC_P10 + \
           B_VEGETATION * df.VEGETATION_10[0] + \
           B_BARRIERS * df.BARRIERS_10[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_10[0] + \
           B_PATHS * df.PATHS_10[0] + \
           B_PROXIMITY * df.PROXIMITY_10[0] + \
           B_LIGHTING * df.LIGHTING_10[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_10[0] + \
           B_WATER * df.WATER_10[0] + \
           B_SEATING * df.SEATING_10[0] + \
           B_TOILETS * df.TOILETS_10[0]
[In 60]:   V10
```

```
[Out 17]:  0.31306303931382956

[In 61]:   V11 = ASC_P11 + \
           B_VEGETATION * df.VEGETATION_11[0] + \
           B_BARRIERS * df.BARRIERS_11[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_11[0] + \
           B_PATHS * df.PATHS_11[0] + \
           B_PROXIMITY * df.PROXIMITY_11[0] + \
           B_LIGHTING * df.LIGHTING_11[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_11[0] + \
           B_WATER * df.WATER_11[0] + \
           B_SEATING * df.SEATING_11[0] + \
           B_TOILETS * df.TOILETS_11[0]
[In 62]:   V11
[Out 18]:  1.6252448741979164

[In 63]:   V12 = ASC_P12 + \
           B_VEGETATION * df.VEGETATION_12[0] + \
           B_BARRIERS * df.BARRIERS_12[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_12[0] + \
           B_PATHS * df.PATHS_12[0] + \
           B_PROXIMITY * df.PROXIMITY_12[0] + \
           B_LIGHTING * df.LIGHTING_12[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_12[0] + \
           B_WATER * df.WATER_12[0] + \
           B_SEATING * df.SEATING_12[0] + \
           B_TOILETS * df.TOILETS_12[0]
[In 64]:   V12
[Out 19]:  1.1297223438006985

[In 65]:   V13 = ASC_P13 + \
           B_VEGETATION * df.VEGETATION_13[0] + \
           B_BARRIERS * df.BARRIERS_13[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_13[0] + \
           B_PATHS * df.PATHS_13[0] + \
           B_PROXIMITY * df.PROXIMITY_13[0] + \
           B_LIGHTING * df.LIGHTING_13[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_13[0] + \
           B_WATER * df.WATER_13[0] + \
           B_SEATING * df.SEATING_13[0] + \
           B_TOILETS * df.TOILETS_13[0]
[In 66]:   V13
[Out 20]:  1.4691237919379196

[In 67]:   V14 = ASC_P14 + \
           B_VEGETATION * df.VEGETATION_14[0] + \
           B_BARRIERS * df.BARRIERS_14[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_14[0] + \
           B_PATHS * df.PATHS_14[0] + \
```



```
           B_PROXIMITY * df.PROXIMITY_14[0] + \
           B_LIGHTING * df.LIGHTING_14[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_14[0] + \
           B_WATER * df.WATER_14[0] + \
           B_SEATING * df.SEATING_14[0] + \
           B_TOILETS * df.TOILETS_14[0]
[In 68]:   V14
[Out 21]:  1.061135056631406

[In 69]:   V15 = ASC_P15 + \
           B_VEGETATION * df.VEGETATION_15[0] + \
           B_BARRIERS * df.BARRIERS_15[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_15[0] + \
           B_PATHS * df.PATHS_15[0] + \
           B_PROXIMITY * df.PROXIMITY_15[0] + \
           B_LIGHTING * df.LIGHTING_15[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_15[0] + \
           B_WATER * df.WATER_15[0] + \
           B_SEATING * df.SEATING_15[0] + \
           B_TOILETS * df.TOILETS_15[0]
[In 70]:   V15
[Out 22]:  3.1347335573140827

[In 71]:   V16 = ASC_P16 + \
           B_VEGETATION * df.VEGETATION_16[0] + \
           B_BARRIERS * df.BARRIERS_16[0] + \
           B_OPPORTUNITIES_PA * df.OPPORTUNITIES_PA_16[0] + \
           B_PATHS * df.PATHS_16[0] + \
           B_PROXIMITY * df.PROXIMITY_16[0] + \
           B_LIGHTING * df.LIGHTING_16[0] + \
           B_SECLUDED_AREAS * df.SECLUDED_AREAS_16[0] + \
           B_WATER * df.WATER_16[0] + \
           B_SEATING * df.SEATING_16[0] + \
           B_TOILETS * df.TOILETS_16[0]
[In 72]:   V16
[Out 23]:  1.2569772032982127
```

STADMAKERS CONGRES2017

Graduation Orientation AR3U040 - Workshop

Liveability is a theme that is important in all of our graduation projects. It is also a topic that will be addressed in many of the Stadmakerscongres workshops in Rotterdam this year. Therefore we will participate in these workshops together, learn from Rotterdam cases and reflect as a group on how these principles can be applied in our own specific projects.

Viola Smit

I would like to gain more knowledge about: the role of the inner city in the future and the importance of livability in the city in relation to the urban form of the city. Because lot of mid-sized Dutch inner cities are losing their shopping function, by which the livability is decreasing. This is useful for my graduation project because I want to research how to revise the urban form of mid-sized Dutch inner cities in order to make is a liveable city, where a new role/identity can emerge.

Susanne Van Rijn

From the Stadsmakerscongres I expect to gain more insight in how to design with the needs and desires of the citizens as a starting point. I would like to know more about working with these citizens and how to connect social issues to our role as urban designers and how we, as urban designers, can contribute to such social issues. This is useful for my own graduation project as the main issue there is the relation between the physical environment (green space) and the wellbeing of people living there and how to influence this through urban design.

STADMAKERS CONGRES2017

Workshop evaluation - Susanne van Rijn (4031598)

During the Stadmakerscongres 2017 I have visited three lectures.

1 | The first lecture was about the 'groene connectie', a connection of green initiatives in Rotterdam. More green space is implemented in the neighbourhoods and at the same time this green network functions as a connection of healthcare places. The initiatives are mainly launched by the inhabitants of the places. The 'groene connectie' is about relating social issues to the physical space. As such it is related to my graduation topic, as I also want to contribute to social issues through the design of physical space. An important thing I concluded from this lecture and that I will use in my graduation project is that when you want to design for the people living somewhere, you have to understand them. It is important to be able to relate to them and define their needs. In the 'groene connectie', a lot of the parks and gardens are initiated by the inhabitants because they thought they could use such a place. I can translate this to my graduation project in that way that I need to contact the inhabitants of Westland and question them about their needs and use this input in the design.

2 | The second lecture was a series of smaller talks on 'places for people'. Different speakers spoke about small initiatives such as Happy Streets on changing the physical environment temporarily. My main observation during this lecture was that one can use small experiments in order to get people to think about more permanent changes in their living environment.

3 | The final lecture I have visited at the Stadmakerscongres was about the vitality of inner cities in a changing context. Two presentations have shown the variety in approaches one could use to research a specific topic. Where the first speakers used data to explore the possibilities for new (shopping) places and tried to develop patterns from this data, the second speakers approached it from a more people oriented perspective. They actually stayed in a city for longer time in order to be able to talk to a lot of different people and just hear from them what they need and where they are proud of in their cities.

Above all it was inspirational to hear this variety of initiatives and examples of 'citymaking'. But beside that, the importance of incorporating the citizens in the research and design is again made clear. The approaches I have heard are helpful to define my own approach for this research, and I will probably use some of them in my graduation project.

1

The 'groene connectie' in Rotterdam

2

Happy Streets

3

Making use of data to explore invisible patterns in cities

Image sources: 1 | Author unknown (2016). De groene connectie. Retrieved November 13, 2017; from: http://www.degroeneconnectie.nl/wp-content/uploads/2016/06/160524-A3_KaartGroeneConnectie_concept-mei-2016.pdf 2 | Author unknown (n.d.). No title. Retrieved November 14, 2017 from: https://www.facebook.com/happystreetsNL/photos/a.997859197001702.1073741827.997850310335924/1551891054931844/?type=3&theater 3 | Author unknown (n.d.). Versterken economische structuur. Retrieved November 14, 2017; from: https://stimuleringsfonds.nl/nl/urbanisatie/voorbij_de_winkelstraat/

Appendix A-10 Transformation Condsiderations

Some general recommendations relating to a transformation of public space using the ten spatial attributes of this thesis are presented here.
The importance of each spatial attribute requires a different approach to intervene in the types of public space. However the combination of important spatial attributes is even more relevant to know, as these attributes can influence and hinder each other. Each attribute on its own only defines a small portion of the composition or distribution of functional activity spaces, and the total outcome is always depends on the other attributes as well.

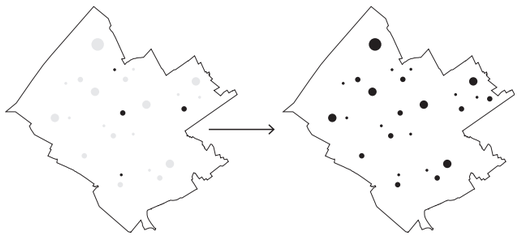


Figure G | Increase distribution of functional activity areas

Proximity
When proximity proves to be the least important attribute, it can suffice to adapt a few larger spaces with a greater reach such as parks or squares than to adapt all small public spaces like play areas. When proximity to home proves to be the most important spatial attribute, the distribution of public spaces that meet the other spatial requirements is essential. Dependent on the other important attributes, areas in Westland that stay behind in terms of distribution can be defined using a buffer of a 5 to 10 minute walk around each space. Solutions to create more activity spaces close to home can be found in making smarter use of the space available: including also left over green spaces at the small scale, or adding extra functions to existing types, based on the other important attributes.

Physical barriers
Because of traffic flows and continuation

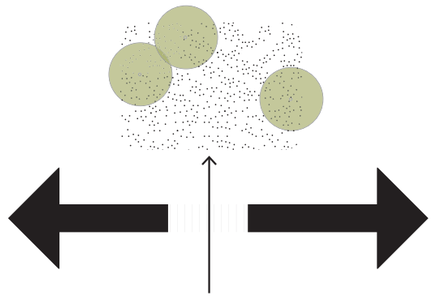


Figure H | Make slow traffic more important at crossings

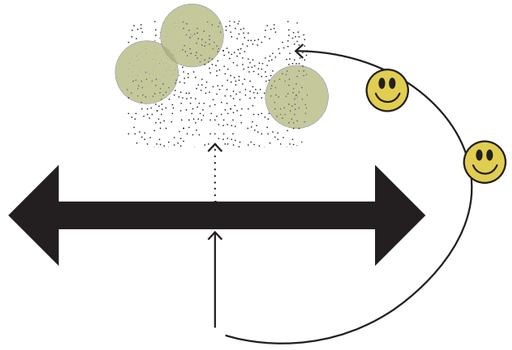


Figure I | Fun and safe alternative routes to overcome physical barriers

of the network, redirecting barrier roads takes some effort. To lower the nuisance of physical barriers adolescents have to wait for, two types of solutions can be thought of: (1) to make the crossings more safe where slow traffic becomes top priority over fast traffic. Or (2) to redirect the slow traffic towards alternative, possibly longer, routes. To increase the probability of adolescents actually taking these routes, they can be made more attractive with extra facilities and high (perceived) safety along the way. Following the other important spatial attributes, and the outcome of the most practiced (physical) activities in public space and in general to define what fun facilities should be along the way. Using e.g. lighting or specific paths for slow traffic to create safe routing. This second option is a bit more related to the qualities of the network, then of the qualities of the space itself.

Opportunities for PA
With use of the survey results on most undertaken physical activities in general and the favourited physical activities in public space (see as well Paragraph 5.1), the top activities for adolescents can be defined. Dependent on the space and potential equipment required for the favourable activities, they can be implemented in either existing types or e.g. in left over green spaces when proximity proves of high importance as well. Key is to ensure the facilities are present at a reasonable scale range.
Vegetation
In particular the combination with the opportunities for physical activities, secluded areas, and water is important to consider for vegetation. The importance of these attributes, together with favourite activities to do in a public space and most

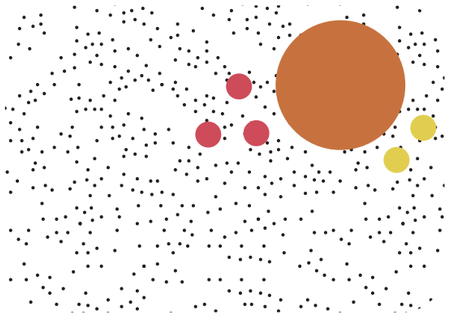


Figure J | Cluster facilities such as seating, equipment for physical activity, and toilets

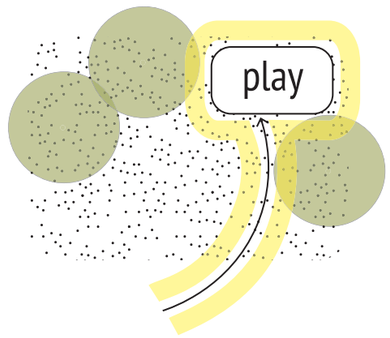


Figure K | Include lighting around other important spatial attributes.

common physical activities determine the type of vegetation to add.

Seating
Adding seating to a public space is quite easy as it requires not that much space. When seating seems important for adolescent physical activity, it is key to look at the other important attributes and ensure this combination of attributes to be present in public spaces.

Lighting
Including lighting in public spaces is dependent on the importance of the other spatial attributes for the exact location of lighting. If opportunities to engage in physical activities appear important too, it is evident to add lighting around this place and around the routing towards.
Another combination can be made with coping with the physical barriers. The alternate routes suggested before can be emphasised with good lighting.

Toilets
In particular relevant for large scale public spaces with a greater reach. For public spaces with a small reach, such as some play areas, adolescents can easily go home to go to the toilet. In terms of required size, toilets are quite easily achievable in e.g. parks or nature areas.

Water
As with vegetation, ‘water’ contains an extensive collection of types and aesthetics. Westland has a lot of existing water in the urban form already. An option for new to be developed public spaces can be to connect to this existing structure, and include the water structure in new public spaces. The larger existing public spaces often already contain water elements.

Water in combination with other attributes:
If walking is an activity often engaged in, and vegetation and paths are important spatial attributes, this can refer to desired scenic routes. Extra routing through the public spaces with a variety in vegetation and watercourses. Parks, nature areas and to a lesser extent recreation areas appear then to be important public space types for adolescents.

Paths
The distinction for paths in the survey is made between paths around and throughout the public space and paths *just around* the public space. Developing paths throughout a space is not for every type feasible: as squares are often already paved, this makes no sense. Developing paths is mainly achievable in the larger public space types of parks and nature areas than in the smaller play areas, and these types often have already paths included. For parks and nature areas it is quite feasible to design extra routes through them. The design of such routes should fit the surrounding environment and create added value to the type. This can potentially be combined with the existing water structure and the adding of extra vegetation.

Secluded areas
When the survey results show that the absence of secluded areas is important for adolescent physical activity behaviour, it is important to find a balance between the character of the public space and its functionality. When e.g. looking at nature areas, part of the pull can be the feeling of being in another scenery, world. These areas are often outside the residential areas, and thus by definition more secluded. From an urban design perspective solutions might be found in redesigning public spaces to feel more safe, and still be attractive.
Or ensure the routing towards desired activites, e.g. sports fields, places to sit, to be well lit and without unclear sight lines and large vegetation.

Another example: when the absence of secluded areas prove to be of much higher importance than the presence of (a high variety of) vegetation, design solutions can be to only add low vegetation bushes and leave out the higher unclear ones.

Key to all recommendations is the combination of spatial attributes that prove important for adolescent physical activity. It is too simple to just say ‘add this or that’ everywhere, this has to be done with thought to not create everywhere the same public spaces, but to keep the unique identity of the type and add a layer of active friendlyness.

respondent in the survey