Infrastructure for cyclists, preference and perception of safety

Transport & Planning bachelor thesis

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Cover image: (Fietsersbond Maastricht, 2020)

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Preface

This thesis focusses on infrastructure for cyclists, preference and perception of safety. My interest in this topic stems from my teenage years where I had to ride long distances to school and every road had different designs with their pros and cons. The thesis is an element of the bachelor Civil Engineering at the Delft University of Technology. The research was conducted at the department of Transport and Planning and was written from April to June 2021.

A survey is used to collect data for the analysis. I would like to thank all the participants of the survey, because without them, the research would never have been possible. The help of my family and friends made it possible to spread the survey to as many different groups as possible. I am very grateful for their help in this process.

I also wish to thank my fellow students of the project group. Their help and feedback made it possible to bring the thesis to a higher level. At last, I want to thank my supervisors, Yufei Yuan and Jisup Shim, for their helpful and well-directed support and feedback during the project.

Enjoy your reading.

B.Z. Vermeulen
Delft, June 2021

SUMMARY

While the amount of traffic deaths with cars decreased with more than 50% in the past 20 years, the amount of cyclists' deaths remained the same. Good road design has an influence on the safety of roads, but only 30% of all the bicycle lanes is wide enough to accommodate two cyclists and 10% is even too small for one. The guidelines for bicycle lanes are not implemented in many cases.

This thesis tries to answer the following question: What type of cross-section is preferred and perceived as safest by cyclists inside and outside urban areas and how does this compare to the guidelines of 'Ontwerpwijzer fietsverkeer'?

The influential factors that have an influence on the perception of safety can be split in three categories: socio economic, road dimensions and external factors. The influential factors used are age, location, ownership of a bicycle and usage frequency for the socio-economic category. For the road dimensions width of the car and bicycle lane, presence of a separation, sidewalk and parking spaces and the distinction of road functions is used. The external factor used is cycling together or alone because this has a direct relationship to the road dimensions. The rest is not considered because these are dynamic factors. The influential factors are used as a basis for the survey.

The Ontwerpwijzer Fietsverkeer guidelines are reviewed and analysed in the study. The guidelines focus mostly on the width of bicycle lanes. It states that the wider the bicycle lane, the better the objective and subjective safety of a road. Therefore, the width of a bicycle lane should always be for two cyclists. Also, the width of the car lane must indicate clearly how the driver must behave.

Outside urban areas, separate bicycle paths are desirable. Bicycle lane designs should only be used at low intensities and roads smaller than 840 cm. There is no design guideline for roads narrower than 580 cm, yet.

A survey is used as the main source of information. The survey states two roads per case. Participants must rate both roads in perception of safety and must state their preference in the end. The survey has 388 respondents from 74 municipalities and they are evenly distributed between different age groups.

To analyse the survey, the Mann-Whitney U test, Kruskal-Wallis H test and Wilcoxon signed-rank test are used to test the significance and approve or reject the hypotheses. The following results are obtained from the analysis.

- People from the age of 45 will feel less safe in general then people up to and including 24.
- People that use the bike weekly or more will have a higher perception of safety then people that use the bike less than once a week.
- People living in urban areas have no significant difference in perception of safety then people living in more rural areas.
- A narrow bicycle lane with the presence of a separation is preferred above a wider bicycle lane that can accommodate two cyclists.
- Cyclists prefer to have no interaction with parking cars, although this means that the bicycle lane will be much smaller.
- The width of a car lane must be wide enough for at least one car but preferably two so that they do not have to use the bicycle lane. Even if this means that the bicycle lane is small.
- Bicycle street design is preferred above a smaller bicycle lane inside urban areas.
- Cyclists prefer a red bicycle lane, so the distinction is clear between space for cyclists and drivers.

- A narrow car lane with bicycle lanes on the sides is preferred above a bicycle street design outside urban areas.

These results do not comply with the guidelines that are now in place. The results state that there should be as less interaction with cars as possible, while the Ontwerpwijzer Fietsverkeer focusses on a minimal width of the bicycle lane for two cyclists. Narrow roads inside urban areas are preferred to be designed as a bicycle street. Outside urban areas, however, bicycle lane design with a narrow car lane is preferred by cyclists.

The focus on minimizing the interaction between different modes of transport should be present in future designs. Marking of a bicycle lane should always be present as well. Future studies could focus on the objective safety and the perception of safety for other modes of transport on the roads. This is especially relevant on the case of a narrow road outside urban areas.

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1 INTRODUCTION

In this chapter an introduction is given to the research about preference and perception of safety for cyclists' infrastructure. In the first paragraph the problem statement is made. Next the research questions are stated and why they contribute to the study. In paragraph three, the goal and scope of the research is defined. Next the stakeholders are discussed and in the last paragraph the outline of the rapport is mentioned.

1.1 PROBLEM STATEMENT

While the amount of traffic deaths with cars decreased with more than 50% in the past 20 years, the amount of cyclists' deaths remained the same. The number of deaths by both ways of travel (bike and car) is about the same number in 2019, but when these numbers are compared by the distance travelled, the mortality rate per km is almost 7 times higher in 2019 (cbs, 2020). Especially the number of registered road deaths on 30 and 60 km/h roads is slightly increasing (Weijermars, 2018).

A big investigation done in 2015 by the ministry of infrastructure and environment with several road authorities concluded that wider cycle paths give a better perception of objective and subjective safety, bicycle lanes should be wide enough for two bikes next to each other and the width of the car lane should suggest the right behaviour for the user (CROW-fietsberaad, 2015). In 2021 Hans Drolenga concluded that although these are the results of the research, it is not implemented in most cases. Only 30% of all the bicycle lanes is wide enough to accommodate two cyclists and 10% is even too small for one (CROW-fietsberaad, 2021).

The research that will be conducted is about the perception of safety and the preference of cyclists for bicycle lanes at different cross-sections of the road. Which type of cross-section is viewed as safe by the user and how does this compare to the guidelines that are now in place by the 'Ontwerpwijzer fietsverkeer' (Kennisplatform CROW, 2016) . This research will investigate if there is a type of lane division that is highly preferred and where can it be implemented.

1.2 RESEARCH QUESTION

This research will try to answer the following question: What type of cross-section is preferred and perceived as safest by cyclists inside and outside urban areas and how does this compare to the guidelines of 'Ontwerpwijzer fietsverkeer'? The sub questions to answer this question are:

- What type of cross-section characteristics are there?

This question will contribute to answering the main question by getting an overview of the possibilities in road design for bicycle lanes.

- Which cross-sections inside and outside urban areas are preferred and perceived as safe by bicycle users and why?

The results of the survey for inside and outside urban areas are evaluated and conclusions are made.

- How does the preferred and subjective safest cross-sections compare to the guidelines?

The comparison will give an overview on what guidelines are seen as most important by the bicycle user.

- What type of cross-sections can be improved to make them more attractive for cyclists?

This will give a few examples of how the cross-sections can be improved. The conclusions are made and used here.

1.3 GOAL AND SCOPE

The goal of this research is to find suitable solutions for the cross-sections that are now perceived as unsafe or unfavourable by bicycle users. Should the guidelines be adjusted or are they in line with the research? Some short cases will be used to visualise possible improvements in width, lining of the road, barriers and pavement type. For example, the width of the of the road can be split differently in car lane and bicycle lane widths and a dashed marking can be used or a non-crossable barrier between both modes of transport.

The study will be done for bicycle infrastructure in The Netherlands inside and outside urban areas. Intersections are excluded from this research.

With the results of this research, municipalities and road authorities can improve the design of cross-sections with bicycle lanes so that they will be safer for all modes of transport that use the roads and roads will become more attractive for cycling. Cyclists will have a more positive experience using these improved roads.

1.4 STAKEHOLDERS

In this chapter, the stakeholders are given with their influence and interest in improvement of the cross-section for cyclists. The stakeholders are discussed in more detail below. The stakeholders are split into two groups: the road users and the road developers and managers.

Table 1: Influence and interest per stakeholder

STAKEHOLDER	INFLUENCE	INTEREST
CYCLISTS	-	++
PEDESTRIANS	--	+
OTHER VRU'S	--	+
CAR USERS	-	0
MUNICIPALITIES	++	+
PROVINCE	+	+
ROAD AUTHORITIES	++	0

1.4.1 Road users

In this research only cyclists will be taken in account. The relation of other road users to the improvement of cross-sections for cyclists is stated below.

Cyclists

Cyclists have a big interest in safer and more favourable roads for cycling. It makes cycling more attractive for them and it will be easier to go around by bicycle for them when the cross-section is improved in their benefit.

The influence cyclists have on the other hand, is small because new developments and redevelopments of existing roads are planned by municipalities, provinces and road authorities. However, these parties include the users more and more in their design process nowadays.

Pedestrians

Inside urban areas pedestrians almost always have a sidewalk, so they do not have to use the bicycle lanes for walking. These sidewalks are not always present outside build-up areas. They must use the bicycle lanes when they want to use the road. This can cause unsafe situations for them and other road users. Therefore, pedestrians have an interest in safer cross-sections when no sidewalk is present. The influence of pedestrians, however, is small.

Other VRU's

Other VRU's, vulnerable road users, like skateboarders, mobility scooters, mopeds etc. use the bicycle lanes as well like cyclists. They often operate at a different speed then cyclists and therefore they have a lot of interaction with each other. An improved cross-section will have a positive experience on these users as well. Their influence is very small.

Car users

Car users do not have a positive interest in a cross-section that is perceived as safer and preferred by cyclists because this will most likely mean that the space for them will increase in the road image with less manoeuvre space as a result. If the new cross-section gives a clearer view of the road, however, without decreasing their space it is beneficial for car users at well. The risk on accidents will become smaller and the attention the road user needs to have, will decrease. The influence of car users is around the same as cyclists.

1.4.2 Road developers and managers

This group of stakeholders is responsible for the design and management of roads. They have a different interest and more influence than road users. The specific interests and influence for each stakeholder is stated below.

Municipalities

Municipalities have a positive interest when cross-sections are safer and preferred by cyclists. Especially inside urban areas, the use of bike is preferred above car use because of pollution and less nuisance. Their influence is large because they are involved in all urban planning.

Province

Like municipalities, provinces have a positive interest in more cyclists. They are responsible for the connector roads between urban areas. They have a lot of influence in these projects.

Road authorities

Road authorities have a lot of influence on the design of roads but have less interest in safer and preferred roads for cyclists, since they only must build and manage the roads.

1.5 Outline

In chapter 2 the methodology is given. First influential factors are discussed together with the current guidelines of Ontwerpwijzer Fietsverkeer. Then the hypotheses, survey and analysis methods are explained. In chapter 3 the analysis of the data itself is given. The chapter starts with a general review of the data and then follows with statistical analyses. First conclusions are drawn as well. In chapter 4 the discussion is presented and the conclusion is stated in chapter 5.

2 METHODOLOGY

To conduct the research, a survey will be set up with schematic representations of different cross-sections throughout the Netherlands. Participants compare several designs and must rate them as safer or less safe. There will be a part about roads in built-up areas as well as a part about the connector roads between cities, so a complete overview is given of the types of roads.

Part one will focus on the influential factors. The second paragraph will focus on the guidelines by Ontwerpwijzer Fietsverkeer. Part three states hypotheses and their connection to the influential factors. Then the survey is described and in the final paragraph the analysis method to compare the results is discussed.

2.1 INFLUENTIAL FACTORS

The perception of safety can be determined as the generalised judgement an individual has about the chance of injury or loss (Centerbury Wellbeing Index, 2021). It is influenced by many different factors. In Figure 1 these factors are presented schematically for the perception of safety of cyclists on a road. The factors are split in three subcategories: social-economic, road dimensions and external conditions. Not all influential factors are used in this study. The factors that are important for the study are highlighted and further described on the next page.

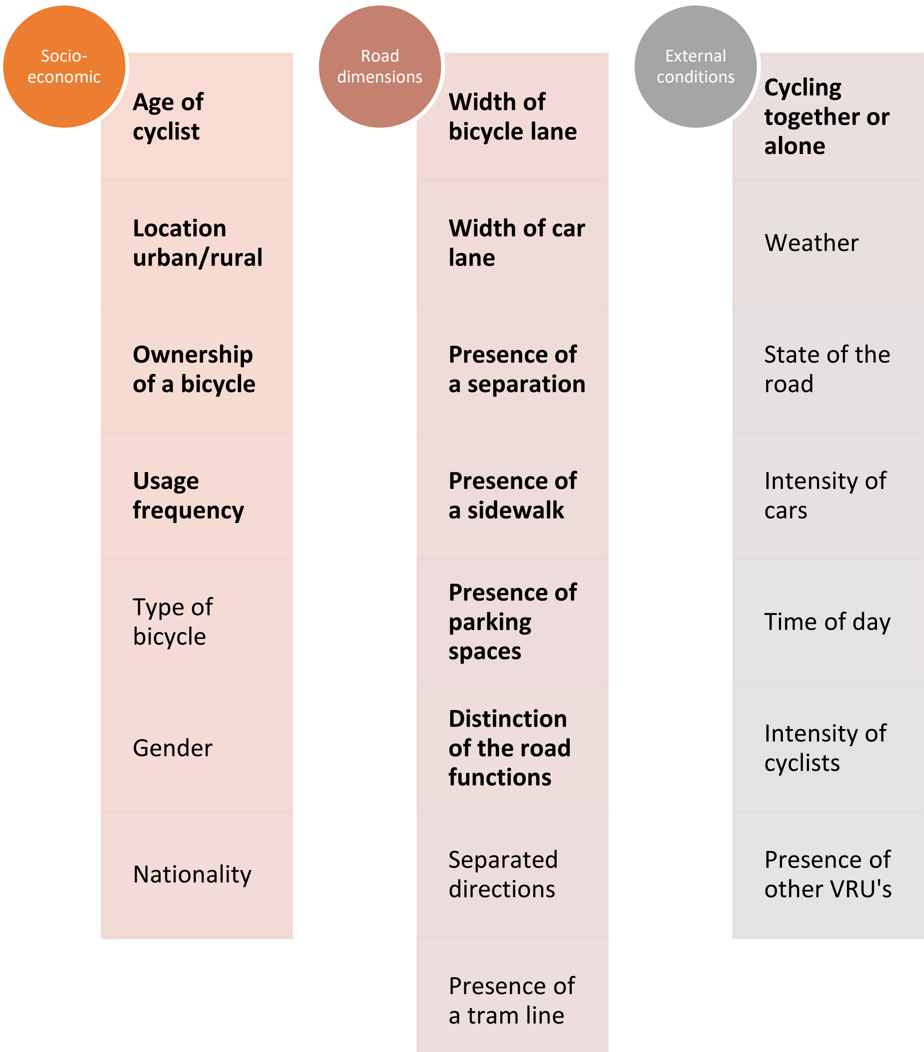

Figure 1: Influential factors of the perception of safety per sub-category

2.1.1 Socio-economic

To be able to generate guidelines for types of roads, the type of users must be determined and their difference in perception of safety. As stated in section 1.1, the risks on accidents differ per socio-economic group. These factors will give a clearer view of which other factors are important per group.

Age of road user

The age of a cyclist is considered because different age groups have a different chance on accidents. Younger age groups are more flexible on the road then older age groups. A difference in the perception of safety can be expected.

Location

The location of residence and therefore the type of roads that are used by the cyclist is considered because there is a difference in road types per municipality. If the road user lives in a more remote part, the road will have different dimensions than in an urban area.

Ownership of a bicycle

If the person does not own a bicycle, the participant could have a different view of the road then when the participant has a bicycle. In general, an owner uses the bicycle and therefore experiences the road as a cyclist instead of just as a car user or pedestrian.

Usage frequency

The difference in use of a bicycle can give different results. If you use this mode of transport many times a week, it can be expected that you feel more comfortable on different types of bicycle lanes than when you use it once a week or less.

Type of bicycle

The type of bicycle can cause a difference in the perception of safety. An e-bike or a racing bike can reach higher speeds than a city bike for example. However, this will not be considered because the influence is very low compared to other factors.

Gender

Gender is not considered in this research because all genders cycle the same amount on average (CBS, 2021).

Nationality

This factor is not considered in this research, because the target group living outside the Netherlands is considered too small to be reached throughout the Netherlands. The study is focused on the Dutch guidelines. Nationality could have influence on the difference in perception of safety. People born in the Netherlands grow up with riding a bike. If you are from another country, however, this is often not the case.

2.1.2 Road dimensions

Almost all road dimension factors are considered. They have a direct consequence for the design of a cross-section, so it is important to determine which factors contribute to a different perception of safety. An overview of the road dimension guidelines by Ontwerpwijzer Fietsverkeer is found in paragraph 2.2.

Width of the bicycle lane

The width of the bicycle lane determines the space that a cyclist can use on a road. In general, the cyclist is not confined to the space of the bicycle lane and the car lane can be used as well. This can be necessary when you want to pass a cyclist. Shadow distance, the safe feeling distance between a passing car and a cyclist, can be included in the width. In conclusion, the width could have an important impact on the perception of safety.

Width of the car lane

The width of a car lane determines if a car must use the bicycle lane to pass an approaching car and the space to manoeuvre past a cyclist. If the car lane is narrow, the interaction between a cyclist and car is bigger. The width of the car lane is therefore expected to have a relation with the perception of safety for cyclists.

Presence of a separation

A separation between the bicycle lane and the car lane can be an influence on the perception of safety. With markings as a separation, both modes of transport can still use each other's lanes. A separation however prevents this.

Presence of a sidewalk

Especially outside urban areas, a sidewalk is not always present. In this case, pedestrians must use the bicycle lane as well as cyclists. This can cause a difference in the perception of safety since an extra mode of transport has to use the same part of the road.

Presence of parking spaces

Parking spaces alongside a road are mostly used in access roads inside urban areas. Destination traffic can park their cars close to their house this way. It is often placed next to bicycle lanes if they are present. The users of this lanes must pay attention to these parked cars. When a car is parking, the lane is shortly blocked and if a car is not parked well, it could partly stand on the bicycle lane. Opening doors can also cause dangerous situations.

Distinction of the road functions

A clearer distinction between the bicycle lane and car lane could influence the perception of safety. A dashed or continuous line between both roads, the type of pavement or a different colour, like the red bicycle lane, are examples of distinctions between both lanes. It could clarify the purpose of every part of the road for the user.

Separated directions

If the directions are separated, road users cannot use the other directional lane to pass each other. This is considered in the study because it could be perceived as safer.

Presence of tram line

When a tram line is present close to the cyclists' path on the road, it is considered unsafe by the user. This must be prevented at all costs in new design and is already known. Therefore, it is not considered in this research.

2.1.3 External factors

The only external factor that is considered is the factor cycling together or alone. The other factors are mostly time dependent and do fluctuate a lot during the day. This rapport is focused on a general cross-section and not for a specific time.

Cycling together or alone

When cycling alone, you need less space than cycling with someone else. This could influence the perception of safety. The cyclist on the outside could also experience the road in a different way than the cyclist on the inside. This is not considered in the study.

Weather

Weather is a dynamic factor and does not have an influence on the design guidelines. It is therefore not considered in this study.

State of the road

Like weather, the state of the road is a factor that does not have an influence on the design of the road but is due to bad maintenance. This factor is not included.

Intensity of cars

This factor is also dynamic and therefore not included in the study. When it is busier, the road is perceived as less safe. This is well known. The cases in the survey have the same intensities to cancel this factor out.

Time of day

Time of day is also a dynamic factor. Night is perceived as less safe than daytime because the visibility is better at daytime.

Intensity of cyclists

Like cars, the intensity of cyclists is dynamic and therefore considered the same in the cases of the survey.

Presence of other VRU's

When other VRU's are present and use the space of cyclists, it can influence the perception of safety. To compensate for this, the presence is the same in every case comparison.

2.1.4 Summary

The influential factors that influence the perception of safety can be categorised into three groups: socio-economic, road dimensions and external factors. Not all influential factors of these groups will be used in this research. Age, location, ownership of a bicycle and usage frequency will be taken in account. For the road dimensions width of the car and bicycle lane, presence of a separation, sidewalk and parking spaces and the distinction of road functions will be used. The external factors are mostly not chosen in this survey because these are dynamic factors. Only the factor cycling together or alone is used because this relates directly to the width of the road.

2.2 GUIDELINES ONTWERPWIJZER FIETSVERKEER

In 2015, the Ontwerpwijzer Fietsverkeer wrote recommendations for the bicycle lanes (CROW-fietsberaad, 2015). In their study where the behaviour of road users was monitored, they came with general conclusions and guidelines for the design of roads. The general conclusions are:

- Wider bicycle lanes provide better objective and subjective road safety.
- Bicycle lanes must always be wide enough for two cyclists.
- The width of the car lane must indicate clearly how a driver must behave.

The following widths are concluded from this study for different cases. The wider the bicycle lane, the higher the appreciation.

- 110 cm: single cyclist with now shadow distance.
- 170 cm: single cyclist with 50 cm shadow distance or two cyclists with no shadow distance.
- 190 cm: Two cyclists without shadow distance.
- 240 cm: Two cyclists with 50 mm shadow distance.
- 290 cm: Two cyclists with a separation of 70 cm. The bicycle lane is a bicycle path now.

An important criterion is that a width of the care lane of 380 to 480 cm must be prevented because it is not clear if the drivers from opposite directions could pass each other without using the bicycle lane or not. It gives dangerous and unpredictable situations.

With this information they state the following solutions should be used inside urban areas. These guidelines will be compared with the results of the survey and recommendations will be written.

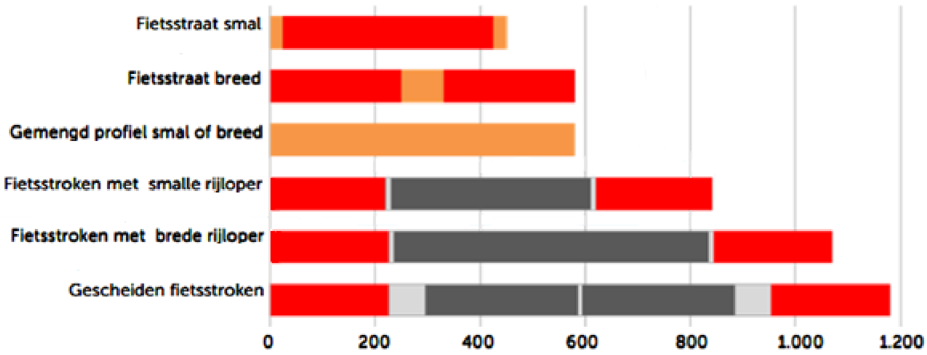

Figure 2: Choice scheme for road design (red is bicycle lane, grey is car lane, light grey is marking or separation, orange is mixed use) (CROW-fietsberaad, Aanbevelingen fiets- en kantstroken, 2015)

Outside urban areas, Bicycle lanes should only be used at roads with low intensities, a width between 580 and 840 cm, low speeds and the car lane should be clear for the user. Separate bicycle paths are desirable. For streets narrower than 580 cm, there is still no general guideline. This will be tried to be composed by this research.

The guidelines stated above will be tested with the survey. Because it is not clear for participants that have no extended knowledge in the design principle of roads, the questions will be descriptive. Every question focusses on one aspect that is related to the general conclusions of the Ontwerpwijzer Fietsverkeer. In this way, conclusions can be drawn and the two can be compared.

2.3 HYPOTHESIS

With the influential factors of paragraph 2.1 the following hypotheses are made. The first hypotheses are focused on finding distinctions between different socio-economic groups in their perception of safety. The second part is focused on the design guidelines to determine if the results from the survey comply with the results Ontwerpwijzer Fietsverkeer. Every hypothesis of this type is answered by one of the questions of the survey.

Socio-economic groups

1. Older bicycle users will feel less safe in general than younger age groups.
2. People that use the bike in a high frequency will feel safer in general.
3. People living in urban areas will have a higher perception of safety than people living in more rural areas.

Inside urban areas

4. A wider bicycle lane is preferred above the presence of a separation and must be able to accommodate at least one cyclist with shadow distance to cars.
5. Cyclists prefer to have no interaction with parking cars, although this means that the bicycle lane will be much smaller.
6. The width of a car lane must be wide enough for at least one car but preferably two so that they do not have to use the bicycle lane. Even if this means that the bicycle lane is small.
7. Bicycle street design is preferred above a smaller bicycle lane.

Outside urban areas

8. Cyclists prefer a red bicycle lane so the distinction is clear between space for cyclists and drivers.
9. A bicycle street design is preferred above a narrow road with two bicycle lanes.

2.4 THE SURVEY

A survey is used to collect data for the research. With a survey a large group of people can be reached and particular questions related to the research can be asked. The survey will be executed in Google Forms. It is free and easy to use for the participants. Most are already familiar with the platform. The survey can be found in appendix A and B. In paragraph 2.4.1 and 2.4.2 the reason for the questions is described.

2.4.1 General questions

The survey starts with some general questions about the participant. These are related to the social-economic factors whose results are compared. The questions include age, residential municipality, ownership of a bike and usage frequency. These questions are mandatory since all the results will be grouped and compared between each socio-economic group. The first three hypotheses can be answered with the results of the survey.

2.4.2 Main part

The main part of the survey consists of 6 questions where participants must rate two cross-sections in safety perception on a scale from 1 (not safe) to 10 (very safe). After this part, their preference is asked on a scale of 1 (strong preference street A) to 6 (strong preference street B). The scale gives participants the chance to have a slight or a large preference for one or the other. At last, they have a multiple-choice question with an open option to state why they prefer one of the streets.

The first four questions focus on the urban area. The factors that are present in each question are stated below.

- The first question is focused on the factors 'width of bicycle lane' and 'presence of separation'. This question relates to the fourth hypothesis: a wider bicycle lane is preferred over a smaller bicycle lane with separation.
- The second question includes factors 'presence of parking spaces' and 'width of bicycle lane'. The focus of this question is on the fifth hypothesis that cyclists do not want to interact with parking cars.
- The third is focused on 'width of car lane', 'width of bicycle lane' and 'cycling together or alone' and answers the hypothesis that cyclists prefer that cars, in general, do not have to use the bicycle lane for passing each other. Even if this means that the bicycle lane is smaller.
- The fourth is about 'distinction of road functions'. The participants are asked if they prefer a design that is more focused on the bicycle usage or car lane and if the bicycle street design is considered safer or not.

The last two questions are about narrow roads outside the urban area. When a wide profile can be used, the bicycle lane is always separated. These narrow roads, however, are not yet clear in the best design.

- The fifth question focuses on 'width of bicycle lane', 'width of car lane' and 'distinction of road functions'. Hypothesis eighth states that a distinction of a bicycle lane is preferred over a grey road.
- The sixth question is a case with these factors as well including the factor 'presence of separation'. Here the bicycle street design outside an urban area is put up against a design with bicycle lanes and a small car lane. It tries to answer the last hypothesis.

2.4.3 The target group

The target group for the survey will be people throughout the Netherlands (both in urban areas and in the countryside) of different age groups so that there can also be a comparison between the different groups in perception of safety and preference.

The goal is at least 100 participants of which at least 20% lives in less urban municipalities so a valid comparison can be made. To reach this target group, personal connections are used. The direct group that will be asked to take and spread the survey consists of about 60 people, of which 30% lives in a different region then South-Holland. If some of them will send it to others, it should provide enough correspondents from different socio-economic groups. The target group turned out to be much larger with 388 respondents. In section 3.1.1 the participants are described.

2.4.4 Images

The images are made on streetmix.net. The website allows you to produce a cross-section with different widths and automatic inclusion of the modes of transport. This produces the same conditions with every comparison in shapes, day/night and angle. The external conditions are not a factor in this way. This is beneficial for this study.

In the first designs, sometimes the number of cars in the picture was different and this could possibly be misread by the participant in the perception of safety. Therefore, some were altered to make the intensities even in the two roads that are compared. The alteration is visualized in Figure 3 with the images of case three as an example.

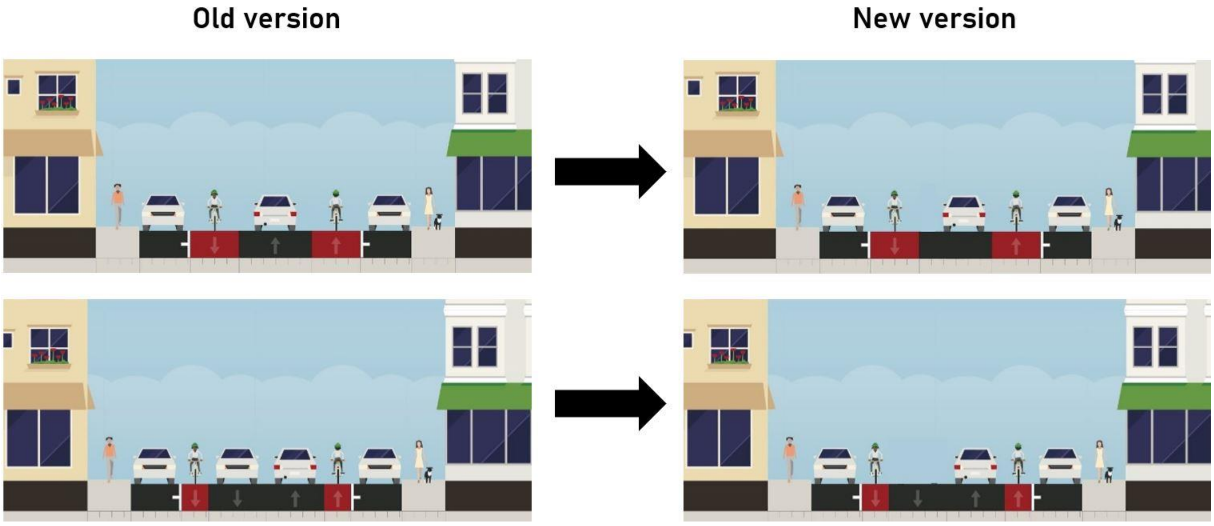

Figure 3: Visualisation of improvement of images, question 3 as an example

2.5 Analysis Method

Multiple statistical methods will be used to analyse the data received from the survey. The questions use a Likert scale to get the results. This is an ordinal data set but can be treated as if it is interval data. In these cases, they are considered to have direction and spacing between them. This property makes it possible to execute other statistical tests. The software program that will be used for the analysis is IBM SPSS. This program is available by the TU Delft and processes the data hypothesis based. The statistical methods used for the analysis of the data are the Mann-Whitney U test, the Kruskal-Wallis H test and the Wilcoxon signed-rank test. These methods are described in the next paragraphs.

2.5.1 Mann-Whitney U

The Mann-Whitney U test is used to test if the median from two independent samples differs. The Mann-Whitney U test is suited for ordinal data sets with the same distribution that are not normally distributed. A t-test could be used if this were the case (studiedata, 2021). The Mann-Whitney U test will be used to determine if there is a significant difference between the perception of safety for people living in urban municipalities or more rural ones in the Netherlands. It will also function as the post hoc test when the Kruskal-Wallis H test shows significance.

All the municipalities will be split in two groups. The urbanity is determined by the environmental address density by the CBS. It classifies a municipality on a scale from one to five where five is determined as very urban and one as not urban (CBS, 2020). Category one and two will be classified as urban municipalities and category three to five will be classified as more rural municipalities. An overview of the municipalities and their classification can be found in appendix C.

The following hypothesis will be tested by combining the average scores per group of the survey. The H_0 is the null-hypothesis stated in paragraph 2.3 and the H_1 the alternative hypothesis that there is no statistical difference between the two groups:

- H_0: People living in urban areas will have a higher perception of safety than people living in more rural areas.
- H_1: There is no difference between people living in urban areas and people living in rural areas in the perception of safety.

After the Mann-Whitney U test is completed, conclusions can be drawn. A p-value smaller than 0.05 is used to determine if there is a statistical difference between both groups.

2.5.2 Kruskal-Wallis H test

The Kruskal-Wallis H test is a test that shows if there is a statistical difference between three or more groups of an independent variable. Ordinal dependent data is the variable that is considered between the groups. It is an extended version of the Mann-Whitney U test. If there is a significant difference after analysing the data, the Mann-Whitney U test must be used to determine which group differ.

To be able to execute this type of test, it is important to determine if the variables are analysable with this test. The dependent variable must be ordinal or continuous. The Likert scale is used in this study so this requirement is met. Next the independent variable must be categorical, independent and every member can be part of just one group. Age and bicycle usage frequency meet these criteria because these are grouped in 7 and 4 intervals that do not overlap. At last, you must determine if the shape of the results of each group is the same. If not, only the mean ranks can be compared and not the medians (Laerd statistics, 2021).

The Kruskal-Wallis H test will be used to get results of the following hypotheses. The age groups will be split in the following categories: <21, 21-24, 25-34, 35-44, 45-54, 55-64, 65<.

- H_0: Older bicycle users will feel less safe in general then younger age groups.
- H_1: There is no difference in perception of safety between age groups.

- H_0: People that use the bike in a high frequency will feel safer in general.
- H_1: There is no difference between the perception of safety of users of bikes.

When the H_0 hypothesis is approved, the groups that differ from each other must still be identified. This is done using the Mann Whitney U test that is described in paragraph 2.5.1 by comparing each group.

2.5.3 Wilcoxon signed-rank test

The Wilcoxon signed-rank test compares data from the same group. It determines if there is a significant difference between the scores that the same participants give to two different situations. The dependent variable must be ordinal or continuous (Laerd statistics, 2021). Because a Likert scale is used, this requirement is met. Also, the groups of participants are categorical and the same which should be the case if you want to perform a Wilcoxon signed-rank test. With the test the significance of the difference in safety perception per influential road design factor can be determined. The p-value is set to less than 0.05, so there is a 95% chance the conclusion is right.

The hypotheses are the same for all six cases and can be found below. With the results, the hypotheses in section 2.3 can be approved or rejected.

- H_0: There is no significant difference between the perception of safety of the two roads.
- H_1: There is a significant difference between the perception of safety between road A and road B.

2.6 SUMMARY

The influential factors of the perception of safety can be split in three categories: socio economic, road dimensions and external factors. Not every factor of every category is considered in the research. The influential factors used are age, location, ownership of a bicycle and usage frequency for the socio-economic category. For the road dimensions width of the car and bicycle lane, presence of a separation, sidewalk and parking spaces and the distinction of road functions is used. The external factor used is cycling together or alone because this has a direct relationship to the road dimensions. The rest are not considered because they are dynamic factors.

The Ontwerpwijzer Fietsverkeer guidelines will be reviewed and analysed in the study. There are different guidelines for inside and outside urban areas. Inside urban areas the following guidelines are given.

- Wider bicycle lanes provide better objective and subjective road safety.
- Bicycle lanes must always be wide enough for two cyclists.
- The width of the car lane must indicate clearly how a driver must behave.

A bicycle lane can be rated from one to five and a higher ranking is always preferred if possible.

Outside urban areas, separate bicycle paths are desirable. Bicycle lanes should only be used at roads with low intensities, a width between 580 and 840 cm, low speeds and the car lane must be clear for the user. For streets narrower than 580 cm there is still no general guideline. This will be tried to be composed by the research.

Nine hypotheses are stated to test the guidelines of the Ontwerpwijzer Fietsverkeer. They all focus on another aspect of road design. The socio-economic factors and their relation to the perception of safety and preference will also be tested.

To be able to approve or reject the hypotheses, a survey is done that states two roads per case. Participants must rate both roads in perception of safety and must state their preference in the end.

After the survey is spread and obtained enough respondents, the results must be analysed. The Mann-Whitney U test, Kruskal-Wallis H test and Wilcoxon signed-rank test will be used to test the significance of the results.

3 SURVEY RESULTS

In this chapter the analytical methods described in paragraph 2.5 will be executed. First the survey results will be described and general observations will be made based on the results of the 388 respondents. In paragraph 3.2 the different statistical tests are computed to test if the results are statistically significant. The critical p-value for all the statistical tests is equal to 0.05, so there is a 95% chance the conclusion is right. IBM SPSS is used to execute the tests. Next in paragraph 3.3, conclusions based on the hypotheses of paragraph 2.3 will be drawn and a summary is given in paragraph 3.4.

3.1 GENERAL OBSERVATIONS

An overview of the results of the survey will be given in this paragraph. First, the groups of participants will be described. Next, general conclusions will be drawn from the results of the survey about the preference and perception of safety. At last, the feedback and comments of the participants will be discussed.

3.1.1 The participants

The survey has 388 respondents from 74 municipalities. The 5 most represented municipalities are Westland, Delft, ‘s-Gravenhage, Deurne and Amsterdam as you can see in Figure 4. Westland and Deurne categorize as rural municipalities based on the environment address density while the other three are classified as urban. The split between more rural and more urban municipalities is 187 to 201 participants so the distribution is about equal.

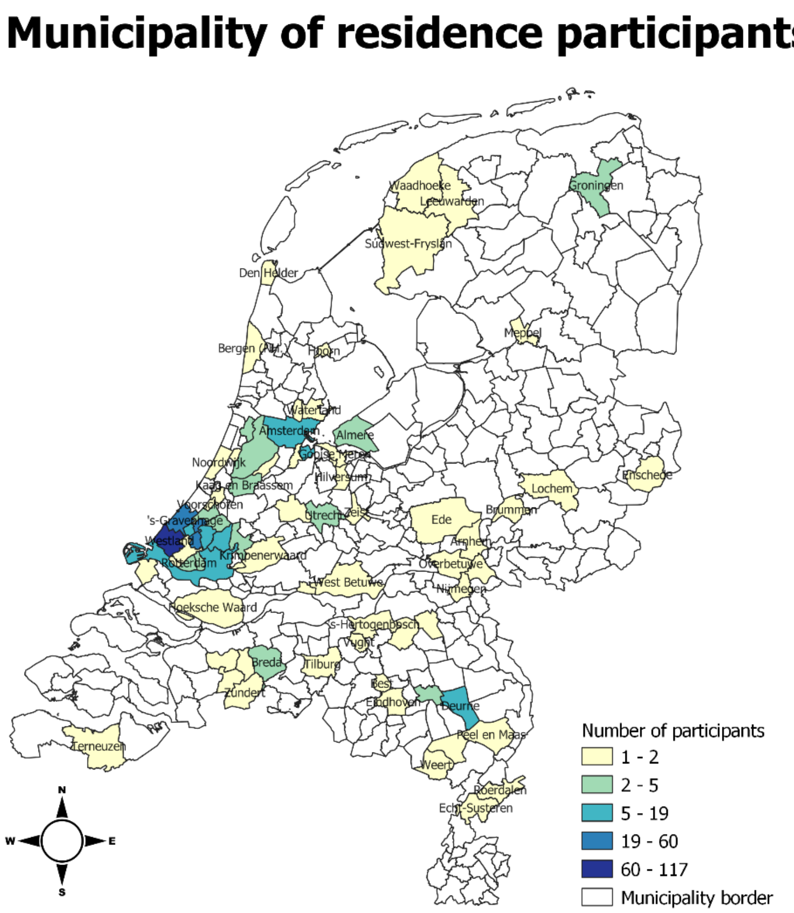

Figure 4: Map of the participants’ residential municipalities with a total of 74 municipalities

The age distribution can be found in Figure 5. As can be seen, every age group is present. The 65+ group has the lowest number of respondents with a total of 8. When looking at the age group distribution per municipality, the younger age groups and the 65+ age group are overrepresented in the urban category. People between the age of 35 and 64 are overrepresented in the rural municipality category. An overview can be found in Table 2.

When the average grade in perception of safety is calculated per age group, it becomes clear that there is an average lower grade when participants are in an older age group. This can be seen with the orange line in Figure 5. The significance of this difference will be calculated in the next paragraph.

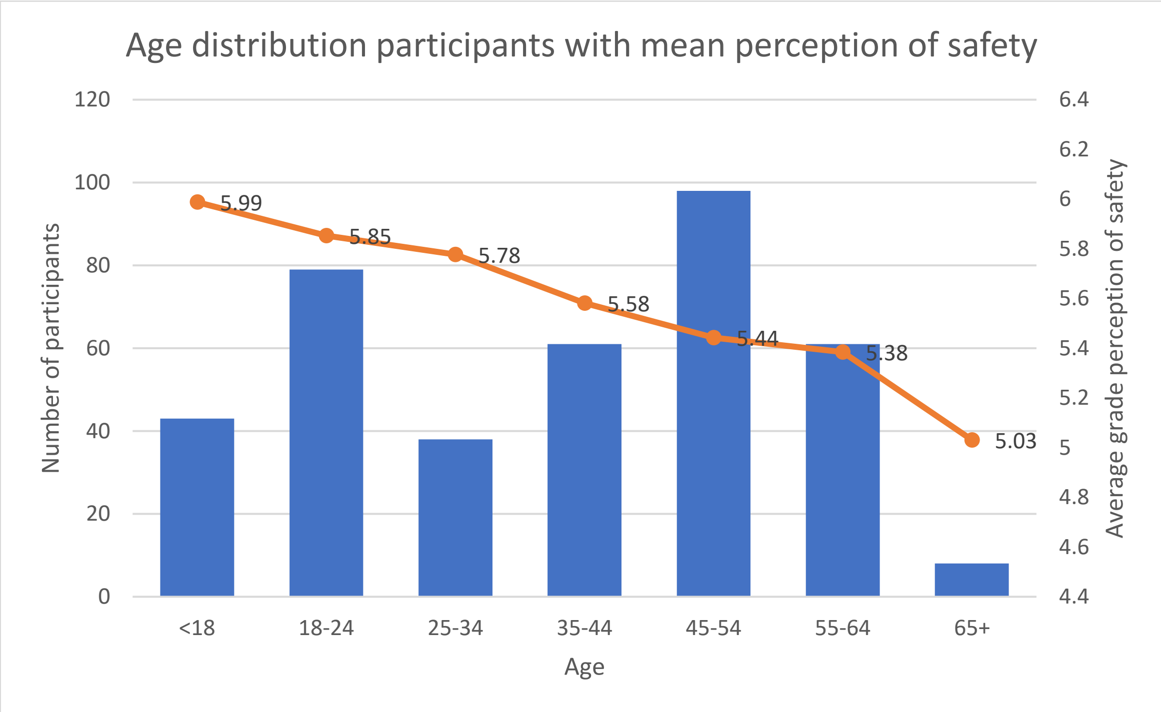

Figure 5: number of participants and average grade perception of safety per age group

Table 2: Split between urban and rural municipalities per age group

		Municipality	
		Urban	Rural
Age group	<18	33	10
	18-24	67	12
	25-34	24	14
	35-44	17	44
	45-54	35	63
	55-64	19	42
	65+	6	2

At last, the bicycle usage frequency and the ownership of a bicycle will be discussed. The distribution of the bicycle usage frequency of the participants is given in Figure 6. Every group is present in a high number. When comparing the usage frequency with the different age groups, the general distribution is about even. The age groups until 24, however, use their bicycle more often than the other groups. This could be related to the fact that people in this age groups do often not possess a car so they must travel by bike or public transport to get to their destination. People from the oldest age groups also use their bike once a week or more and are not present in the lowest bicycle usage group.

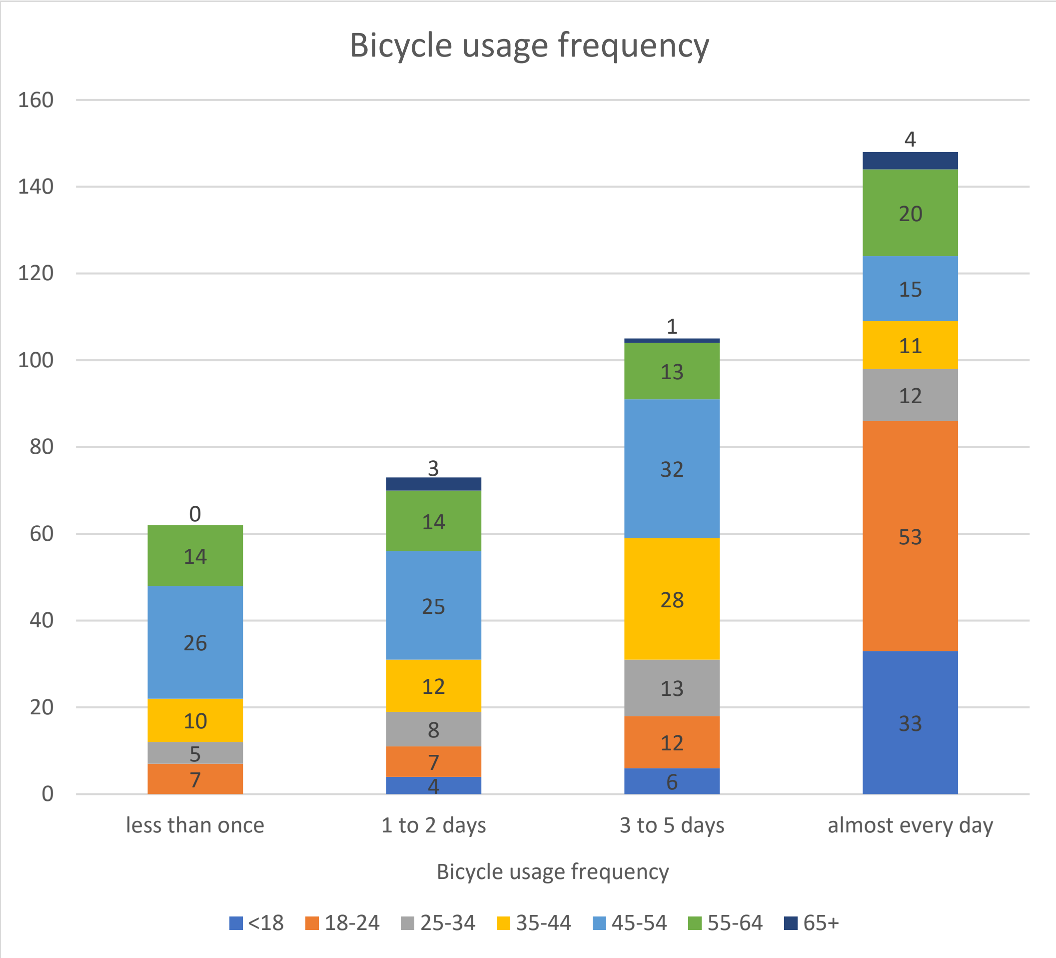

Figure 6: Bicycle usage frequency split per age group

The influential factor ownership of a bicycle will be left out since only 4 participants on a group of 388 do not own one. A comparison between the ownership groups is therefore not valid.

3.1.2 First observations

After computing the mean perception of safety per road design, first observations can be done to determine which road design is perceived as safer. This is shown in Figure 7. Every case has a short description to specify the main factor of difference between the roads. The minimum value of difference is 0.84 on a scale from 1 to 10 where the width of the car and bicycle lanes are presented. The rest of the cases has a larger difference. In section 3.2.3 the significance will be tested, but the prediction is that this is the case. Therefore, every case has a valid result that can be compared to the guideline Ontwerpwijzer Fietsverkeer.

When looking at the preference in one of the roads per case, this is in line with the referential perception of safety. Figure 8 shows standardized results of the survey for preference and perception of safety. Both point in the direction of the same road, so the perception of safety and preference are the same for every case. The perception of safety, however, is rated stronger for one road then the preference the participants have.

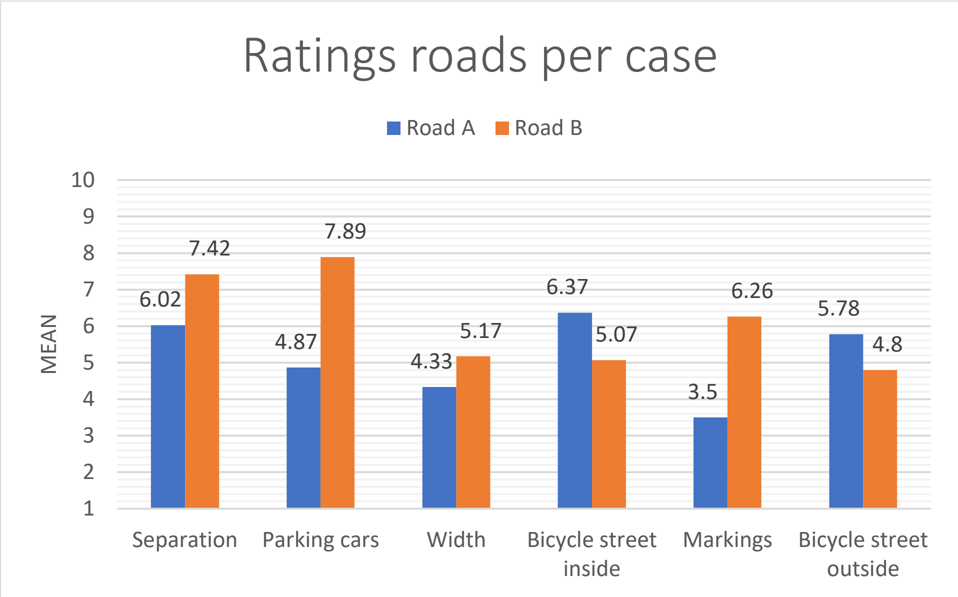

Figure 7: Average perception of safety per case for both roads

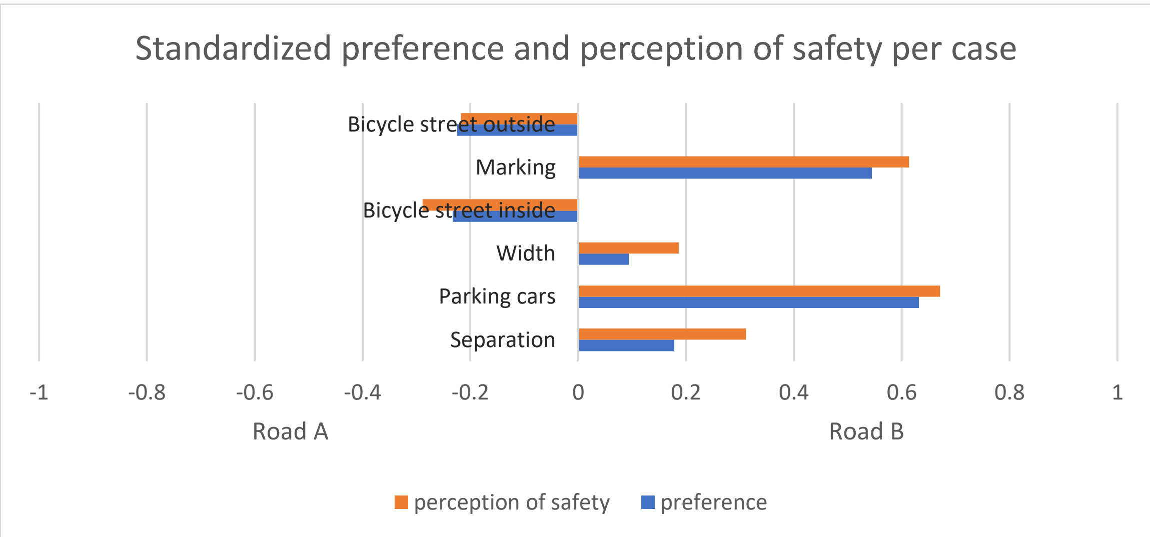

Figure 8: Standardized preference and perception of safety per case. The more the graph extends from the middle, the higher the preference

3.2 Statistical Analysis

To validate the results of the survey, different statistical tests will be used to determine if there is a statistical difference between two or more variables. The test used are the Mann-Whitney U test, the Kruskal-Wallis H test and the Wilcoxon signed-rank test. The first two will be used to determine if the difference between the social-economic groups is significant. The Wilcoxon signed-rank test will determine if the difference in perception of safety of road A and B per case is significant. The tables of the statistical tests can be found in Appendix D.

3.2.1 Mann-Whitney U test

The Mann-Whitney U test is used to determine if there is a significant difference in perception of safety between the more urban municipalities and the more rural municipalities. The resulting p-value of the test is 0.21, which is higher than 0.05, so the difference between more urban and rural municipalities is not significant. The mean rank of the rural municipality group is a little bit lower but the value is not significant enough to validate this result. Living in an urban or rural municipality is therefore not a significant factor that changes the perception of safety for bicycle users and the design guidelines can be applied in municipalities with different degrees of urbanity.

3.2.2 Kruskal-Wallis H test

The Kruskal-Wallis H test is used for multiple socio-economic groups. First the age groups will be discussed. Then the usage frequency groups will be analysed. When the result is significant, further tests must be done to determine between which groups this difference is present. The Mann-Whitney U test is then used to compare every group with each other.

Age groups

The Kruskal-Wallis H test gives a significance of 0.007 by comparing the different age groups with their perception of safety. This is way below the minimal p-value so there is a significant difference. The Mann-Whitney U test is used to determine between which groups the significance is. As can be seen in Table 3, the two youngest age groups show a significant difference in safety perception compared to the groups from 45 years old and up. The 25-34 age group also still shows a significant difference compared to the oldest age group. All the younger groups have a significant higher perception of safety compared to these older groups. As a result, there should be extra attention to the perception of safety for older users.

Table 3: significance between age groups in the perception of safety

	18-24	25-34	35-44	45-54	55-64	65+
<18	0.429	0.260	0.079	0.005	0.007	0.007
18-24		0.716	0.245	0.016	0.015	0.017
25-34			0.553	0.100	0.117	0.027
35-44				0.337	0.234	0.120
45-54					0.740	0.246
55-64						0.281

Bicycle usage frequency groups

The Kruskal-Wallis H test gives a significance of 0.001 when looking at the usage frequency groups and their difference in perception of safety so it is valid. With using the Mann-Whitney U test, more insight can be given on which groups have a significant difference. As Table 4 shows, the group ‘less than once’ has a significant difference in the perception of safety compared to the other groups.

Their score is significantly lower than the groups that use the bicycle more frequently. The other groups do not show a significant difference compared to each other. So in conclusion, only people that use a bicycle less then once a week have a lower perception of safety. 16% of the participants is in that group, but because they use the bicycle lanes on such a low frequency, there does not have to be extra attention to them.

Table 4: significance between bicycle usage frequency groups in the perception of safety

	1 to 2 days	3 to 5 days	almost every day
less than once	0.008	0.000	0.000
1 to 2 days		0.462	0.604
3 to 5 days			0.708

3.2.3 Wilcoxon signed-rank test

The Wilcoxon signed-rank test is used to determine if the difference in perception of safety between the two roads that are described per case is significant. The perception of safety between the two roads is statistically significant because all the cases give a p-value of 0.000. This is much smaller than 0.05. This means that road B is preferred by looking at separation, parking cars, width and marking and that road A is preferred when looking at the bicycle street inside and outside urban areas. The results because of this are found in section 3.4.

3.3 Feedback and comments

Participants in the survey could give feedback and leave comments at the end of the survey. The feedback and comments related to the study are listed below.

- The images are clear
- The questions are difficult to read sometimes
- Speed is also an influential factor
- Intensity is also an influential factor
- Different modes of transport could be included, like scooter, e-bike etc.
- Fully separated roads are clearer and safer
- Wider bicycle lanes are important for e-bikes
- A clear marking between bicycle lane and car lane with colour and lines is preferable
- Small bicycle lanes are dangerous for wider vehicles like cargo bikes, recumbent bikes, tricycles etc.

From this information some conclusions can be drawn about the survey. The survey itself for example should have given the maximum speed and intensities per case so it is clearer what the exact situation is. Also, other modes of transport could have been considered because some use the roads as well.

The other part of the feedback is about the road design in general. A lot of respondents state that they highly prefer a separate bicycle lane so there is no interaction with cars at all, but the profiles of the study are almost all too narrow to accommodate this. These narrow profiles are the scope of the survey. A clear marking is stated as important as well multiple times. This means that dashed or continuous lines with red asphalt are preferred.

At last, there are some comments about the dangers of small bicycle lanes for wider vehicles and e-bikes. A wide bicycle lane is important for these users so they fit on their lane and for e-bikes that they can pass others.

3.4 Final results

After finishing the analysis, conclusions can be drawn to approve or reject the hypotheses of paragraph 2.3. This will be done in this part. The significance tests of paragraph 3.3 state if there is a significant difference so the outcomes can be validated. For every hypothesis, the conclusions are written below.

3.4.1 Socio-economic groups

The first hypothesis is that *older bicycle users will feel less safe in general then younger age groups*. This is proven by the Kruskal-Wallis H test. The young age groups, up to and including 24 years old, has a significant higher perception of safety than the age groups from 45 years old and above. This can also be seen in Figure 5, where the mean perception of safety per age group is lower as it gets older.

The next hypothesis states that *people that use the bike in a high frequency will feel safer in genera*l. This is approved by the Kruskal-Wallis H test as well. Participants that use a bicycle less than once a week generally have a lower perception of safety then people that use their bicycle once a week and higher. Every age group is represented in the different bicycle usage frequency so there is not a high chance that there is a correlation between both.

The third hypothesis states that *people living in urban areas will have a higher perception of safety then people living in more rural areas*. The Mann-Whitney U test, however, shows that although the mean of both groups is different, the difference is not significant. Therefore, the hypothesis is rejected.

3.4.2 Inside urban areas

The first case of the survey is made to validate if *a wider bicycle lane is preferred above the presence of a separation and must be able to accommodate at least one cyclist with shadow distance to cars*. Nevertheless, this is rejected by the results of the survey. Participants preferred the road with a separation while this meant that the bicycle lane is smaller. Their most important reason is that they prefer to have no interaction with cars. The group that chose road A, however, states that it is difficult to pass each other and that it is not possible to dodge a danger on the road.

Next the hypothesis that *cyclists prefer to have no interaction with parking cars, although this means that the bicycle lane will be much smaller* is tested. This hypothesis is approved with a large preference for road B. This road has a full separation of the care lanes with parking spots next to it and a separate bicycle lane in both directions. The most important reason is that the interaction between both modes of transport is gone and that interaction with parking cars must be avoided. Cars need to use the bicycle lane more often to be able to park their cars and opening doors can be very dangerous. The bicycle lane is narrow so some reactions stated that it is dependent on the fact if mopeds drive on the car lane or not. If not, it can be more dangerous.

The third case about width tries to answer the question if *the width of a car lane must be wide enough for at least one car but preferably two so that they do not have to use the bicycle lane*. Even if this means that the bicycle lane is small. The difference in perception of safety and the preference for one of the two roads was small here. The only difference being that the width of the bicycle lane is different but the width of the whole road stays the same. The difference is still significant and a narrower bicycle lane where passenger cars do not have to use the bicycle lane is preferred. The most important reason being that the bicycle lane is less used by cars. On the other hand, participants that chose road A state that the car is more a guest and the bicycle is better represented when the bicycle lane is wider. The hypothesis is approved.

Bicycle street design is preferred above a smaller bicycle lane is the next hypothesis. Case 4 answers this. The bicycle lane is here chosen above a street design with a small car lane and bicycle lanes at the sides, because the priority lies more to the cyclist and cars are a guest. As a sidenote, participants state that it is dependent on the behaviour of the users and that the behaviour can be unpredictable.

3.4.3 Outside urban areas

In case five about markings, the hypothesis *cyclists prefer a red bicycle lane so the distinction is clear between space for cyclists and drivers* is proven. 93.9% of the participants prefer the road with markings above the road without them. It is clear that cyclists are present in the street profile and there is more priority to the cyclist.

At last, *a bicycle street design is preferred above a narrow road with two bicycle lanes* is tested. This hypothesis is rejected by the results of the survey. Participants prefer a bicycle lane design above the bicycle street design because the bicycle street can cause unpredictable behaviour. As a sidenote, the bicycle street design used is unclear to some participants.

3.4.4 Overview

Table 5 gives an overview of the hypotheses and if they are approved or rejected. More information can be read in section 3.4.1 to 3.4.3.

Table 5: An overview of the hypotheses and if they are rejected or approved

1.	Older bicycle users will feel less safe in general than younger age groups.	Approved
2.	People that use the bike in a high frequency will feel safer in general.	Approved
3.	People living in urban areas will have a higher perception of safety then people living in more rural areas.	Rejected (not significant)
4.	A wider bicycle lane is preferred above the presence of a separation and must be able to accommodate at least one cyclist with shadow distance to cars.	Rejected (other way around)
5.	Cyclists prefer to have no interaction with parking cars, although this means that the bicycle lane will be much smaller.	Approved
6.	The width of a car lane must be wide enough for at least one car but preferably two so that they do not have to use the bicycle lane. Even if this means that the bicycle lane is small.	Approved
7.	Bicycle street design is preferred above a smaller bicycle lane inside urban areas.	Approved
8.	Cyclists prefer a red bicycle lane so the distinction is clear between space for cyclists and drivers.	Approved
9.	A bicycle street design is preferred above a narrow road with two bicycle lanes.	Rejected (other way around)

4 DISCUSSION

In the discussion, first the results are compared to the existing guidelines and interpretated. The implications of the study and future recommendations are given. Next, the limitations and constraints of the research and methodology are stated.

4.1 INTERPRETATION AND IMPLICATIONS

With the results found in the previous chapter, a comparison with the research of Ontwerpwijzer Fietsverkeer can be made. The Ontwerpwijzer Fietsverkeer states that a bicycle lane should always be wide enough for two cyclists and that the objective and subjective safety is improved if a bicycle lane is wider. Instead, this research indicates that the subjective safety is improved if there is less to no interaction with cars. Participants stated that separate bicycle paths are perceived as the safest option, if possible. The research meanly focusses on the case where this is not an option. In these cases, the car lane should always be wide enough for two passenger cars, so they do not have to use the bicycle lane to pass each other. A bicycle lane wide enough for one cyclist is then sufficient. Interaction with parking cars should be avoided.

A bicycle street design is preferred for narrow roads where this is not possible to accommodate these criteria. This is in line with the Ontwerpwijzer Fietsverkeer, but they also state that when the intensity is high, a so-called grey street should be implemented where no bicycle lane marking is present. The results show that bicycle lane markings are always preferred by cyclists and that they should always be implemented.

There were no design guidelines for roads outside urban areas with a width less than 580 cm, yet. A grey road design is therefore used most of the time. This research shows that this is not the best design for cyclists. They prefer a design with wide bicycle lanes for at least one cyclist and a narrow car lane that is too small for one car. This is also preferred over a bicycle street design. The bicycle lane design shows that cyclists are present in the road image and give them priority.

The results implicate that the guidelines from Ontwerpwijzer Fietsverkeer should be reconsidered. Only 30% of all the bicycle lanes in the Netherlands do comply with these guidelines and, as the research shows, narrow bicycle lanes are often seen as safer when it results in less interaction with cars.

Further research should be done about the objective safety for narrower bicycle lane designs, so this can be compared with cyclists' perception of safety. For narrow roads outside urban areas, the bicycle lane design should be implemented and this design could be included in the existing guidelines. The objective safety for this type of road must still be research to make a comparison if this type of safety is supported by this design as well.

4.2 LIMITATIONS AND CONSTRAINTS

The methodological choices were constrained by some design factors of the survey. A definition of the perception of safety at the start of the survey gives the participants a more uniform definition while making the survey. The design of the bicycle street outside urban areas in case six was not clear to the participants in some cases. A more simplistic design could have been rated higher because people are more familiar with the design.

Also, the choice of a 1-10 scale is not recommended, because it gives to many options between not safe and very safe. This is different for every participant and open for interpretation. A scale between four and seven intervals with a description of every number might have given more uniform results, because all participants give the same rating to every number.

The maximum speed and intensities could have been included in the questions because these influence the perception of safety. The roads that are compared, however, have the same number of vehicles and are considered to have the same maximum speed. A traffic sign could have made this clearer. Other modes of transport are not included as well, while some of them use the bicycle lane. Their presence is so small that they are not taken in account in this study.

5 Conclusion

This research tried to answer the following question: "*What type of cross-section is preferred and perceived as safest by cyclists inside and outside urban areas and how does this compare to the guidelines of Ontwerpwijzer Fietsverkeer*?" The research question is answered by the analysis of a survey focused on different road design aspects.

Based on the survey with statistical analysis, it can be concluded that guidelines based on the objective safety differ from the perceived safety on the following aspects. Instead of a focus on a minimal width of bicycle lanes for two cyclists, the focus should be on as less interaction with cars as possible. This can be achieved by a physical separation between the car and bicycle lane, no parking spaces next to the bicycle lane and a car lane that is wide enough for two cars to pass each other. These should be implemented, even if it means the bicycle lane is only wide enough for one cyclist. On narrow roads outside urban areas a bicycle lane for at least one cyclist on both sides with a narrow car lane should be applied, while inside urban areas a bicycle street design is preferred. There should always be a marking of the bicycle lane in red.

This research clearly focussed on the perception of safety for cyclists, but the objective safety and perception of safety of other modes of transport is not considered. Future studies could address these different views and compare those results with this study. Especially for designs outside urban areas, future studies should be done on the objective safety. The wide bicycle lane design is promising but should still be tested on this type of safety.

Only 30% of the bicycle lanes in the Netherlands comply with the existing guidelines. This research shows that these guidelines could be reconsidered and that narrower bicycle lanes could also be a solution for narrow road designs based on the safety perception of bicycle users. The focus in road design should be on prevention of interaction between cars and bicycles.

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APPENDICES

A. The survey in Dutch

Voorkeur en gevoel van veiligheid fietsers

De enquête bestaat uit 6 vragen waarin u met het balkje aan kunt geven welke weg uw voorkeur heeft en hoe veilig beide wegen voelen. De enquête duurt ongeveer 5 minuten.

Deze enquête vormt de basis van mijn Bachelor Eindproject Civiele Techniek. Het onderzoek richt zich op de voorkeur en het gevoel van veiligheid voor fietsers bij wegen met verschillende doorsnedes.

Alvast hartelijk dank voor het invullen van de enquête.

Algemene informatie

Wat is uw leeftijd? *

Jouw antwoord

In welke gemeente woont u? *

Kiezen

Bent u in het bezit van een fiets? *

- ○ Ja
- ○ Nee

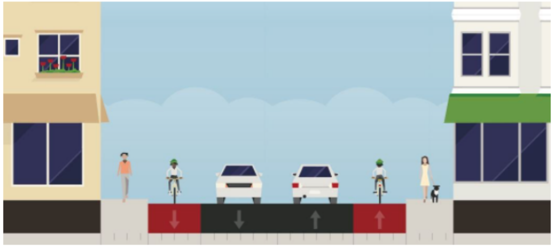
Hoeveel dagen van de week gebruikt u de fiets? (voor COVID-19) *

- ○ minder dan 1 dag per week
- ○ 1 tot 2 dagen
- ○ 3 tot 5 dagen
- ○ (bijna) elke dag

Wegen vergelijken 1 van 6

Geef met het balkje aan welke weg uw voorkeur heeft en hoe veilig beide wegen voelen als fietser. Aan het einde kiest u uw voorkeur en waarom.

Weg A: brede fietsstrook voor twee fietsers zonder rijbaanscheiding. Auto's kunnen over de fietsstrook en fietsers kunnen inhalen over de autoweg.



Hoe veilig vindt u weg A? *

	1	2	3	4	5	6	7	8	9	10	
Niet veilig	○	○	○	○	○	○	○	○	○	○	Heel veilig

Weg B: smallere fietsstrook voor één fietser en verhoogde scheiding tussen fiets en auto. Auto en fiets kunnen beide niet meer over elkaars weg.

Hoe veilig vindt u weg B? *

	1	2	3	4	5	6	7	8	9	10	
Niet veilig	○	○	○	○	○	○	○	○	○	○	Heel veilig

Hoe veilig vindt u weg B? *

	1	2	3	4	5	6	7	8	9	10	
Niet veilig	○	○	○	○	○	○	○	○	○	○	Heel veilig

Welke weg heeft uw voorkeur? *

Hoe meer richting 1 of 6, hoe sterker de voorkeur

	1	2	3	4	5	6	
Weg A	○	○	○	○	○	○	Weg B

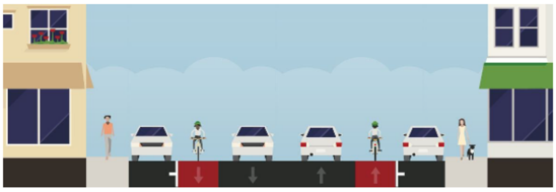
Waarom heeft deze weg uw voorkeur? *

- ☐ De fietsstrook is breed genoeg voor twee fietsers (Weg A)
- ☐ Fietsers kunnen inhalen over de autobaan (Weg A)
- ☐ Auto's kunnen niet meer op de fietsstrook (weg B)
- ☐ Een fietsstrook voor één fietser is breed genoeg (weg B)
- ☐ Anders:

Wegen vergelijken 2 van 6

Geef met het balkje aan welke weg uw voorkeur heeft en hoe veilig beide wegen voelen als fietser. Aan het einde kiest u uw voorkeur en waarom

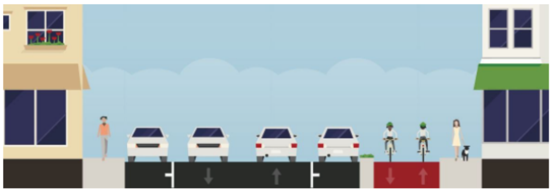
Weg A: fietstrook voor ruim één fietser met parkeergelegenheid ernaast. Fietsers kunnen gebruik maken van de autoweg voor inhalen.



Hoe veilig vindt u weg A? *

	1	2	3	4	5	6	7	8	9	10	
Niet veilig	○	○	○	○	○	○	○	○	○	○	Heel veilig

Weg B: Smal tweezijdig fietspad. Je moet inhalen over de tegengestelde richting. Fiets en auto zijn gescheiden. Parkeergelegenheid langs autoweg.



Hoe veilig vindt u weg B? *

	1	2	3	4	5	6	7	8	9	10	
Niet veilig	○	○	○	○	○	○	○	○	○	○	Heel veilig

Welke weg heeft uw voorkeur? *

Hoe meer richting 1 of 6, hoe sterker de voorkeur

	1	2	3	4	5	6	
Weg A	○	○	○	○	○	○	Weg B

Waarom heeft deze weg uw voorkeur? *

- ☐ De fietsstrook is breder (Weg A)
- ☐ Fietsers kunnen inhalen over de autobaan (Weg A)
- ☐ Fietsers hebben geen last meer van parkerende auto's (weg B)
- ☐ Fietsverkeer en autoverkeer zijn volledig gescheiden (weg B)
- ☐ Anders: ______

Wegen vergelijken 3 van 6

Geef met het balkje aan welke weg uw voorkeur heeft en hoe veilig beide wegen voelen als fietser. Aan het einde kiest u uw voorkeur en waarom.

Weg A: Tweerichtingsverkeer met parkeergelegenheid. De fietsstrook is breed genoeg voor twee fietsers. Auto's moeten uitwijken over de fietsstrook als er tegenliggers zijn.

Hoe veilig vindt u weg A? *

	1	2	3	4	5	6	7	8	9	10	
Niet veilig	○	○	○	○	○	○	○	○	○	○	Heel veilig

Weg B: Zelfde breedte als weg A. De fietsstrook is de minimale breedte voor een fietser. Personenauto's kunnen elkaar passeren zonder over de fietsstrook te gaan. Brede auto's moeten wel uitwijken over het fietspad.

Hoe veilig vindt u weg B? *

	1	2	3	4	5	6	7	8	9	10	
Niet veilig	○	○	○	○	○	○	○	○	○	○	Heel veilig

Welke weg heeft uw voorkeur? *

Hoe meer richting 1 of 6, hoe sterker de voorkeur

	1	2	3	4	5	6	
Weg A	○	○	○	○	○	○	Weg B

Waarom heeft deze weg uw voorkeur? *

- ☐ De fietsstrook is breed genoeg voor twee fietsers (Weg A)
- ☐ De fietsstrook valt beter op (Weg A)
- ☐ Personenauto's hoeven niet over de fietsstrook om elkaar te passeren (weg B)
- ☐ De weg kan ook gebruikt worden door fietsers (weg B)
- ☐ Anders: ______

Wegen vergelijken 4 van 6

Geef met het balkje aan welke weg uw voorkeur heeft en hoe veilig beide wegen voelen als fietser. Aan het einde kiest u uw voorkeur en waarom.

Weg A: Brede fietsstraat met auto's te gast. Tweerichtingsverkeer. De markering in het midden is iets verhoogd, maar je kan er wel overheen met auto en fiets.

Hoe veilig vindt u weg A? *

	1	2	3	4	5	6	7	8	9	10	
Niet veilig	○	○	○	○	○	○	○	○	○	○	Heel veilig

Weg B: Zelfde breedte als weg A. Fietsstroken voor één fietser en een smalle rijstrook. Tweerichtingsverkeer. Auto's moeten uitwijken over de fietsstrook.

Hoe veilig vindt u weg B? *

	1	2	3	4	5	6	7	8	9	10	
Niet veilig	○	○	○	○	○	○	○	○	○	○	Heel veilig

Welke weg heeft uw voorkeur? *

Hoe meer richting 1 of 6, hoe sterker de voorkeur

	1	2	3	4	5	6	
Weg A	○	○	○	○	○	○	Weg B

Waarom heeft deze weg uw voorkeur? *

- ☐ De prioriteit ligt bij de fietsers door het uiterlijk (Weg A)
- ☐ Auto's voelen zich te gast en zijn hierdoor voorzichtiger (Weg A)
- ☐ Het is duidelijk waar auto's moeten rijden (weg B)
- ☐ Er is minder kans op onvoorspelbaar rijgedrag (weg B)
- ☐ Anders:

Wegen vergelijken 5 van 6

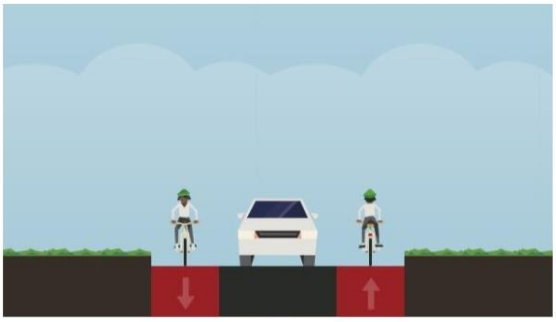
Geef met het balkje aan welke weg uw voorkeur heeft en hoe veilig beide wegen voelen. Aan het einde kiest u uw voorkeur en waarom

Weg A: smalle weg buiten de bebouwde kom met tweerichtingsverkeer. Er is geen aparte fietsstrook aanwezig.

Hoe veilig vindt u weg A? *

	1	2	3	4	5	6	7	8	9	10	
Niet veilig	○	○	○	○	○	○	○	○	○	○	Heel veilig

Weg B: smalle weg buiten de bebouwde kom met tweerichtingsverkeer. Er is een fietsstrook aanwezig. Auto's moeten uitwijken over de fietsstrook.



Hoe veilig vindt u weg B? *

	1	2	3	4	5	6	7	8	9	10	
Niet veilig	○	○	○	○	○	○	○	○	○	○	Heel veilig

Welke weg heeft uw voorkeur? *

Hoe meer richting 1 of 6, hoe sterker de voorkeur

	1	2	3	4	5	6	
Weg A	○	○	○	○	○	○	Weg B

Waarom heeft deze weg uw voorkeur? *

- ☐ Auto's hoeven niet uit te wijken over de fietsstrook (Weg A)
- ☐ De weg heeft dezelfde kleur asfalt (Weg A)
- ☐ Het is duidelijk dat er fietsers aanwezig zijn door de fietsstrook (weg B)
- ☐ Fietsers krijgen meer prioriteit (weg B)
- ☐ Anders:

Wegen vergelijken 6 van 6

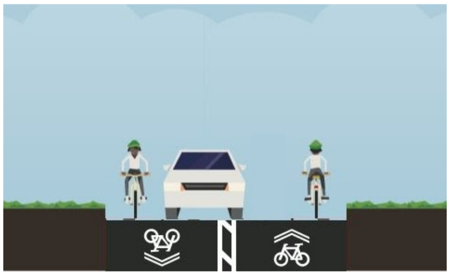
Geef met het balkje aan welke weg uw voorkeur heeft en hoe veilig beide wegen voelen. Aan het einde kiest u uw voorkeur en waarom

Weg A: smalle weg buiten de bebouwde kom met tweerichtingsverkeer. Er is een fietsstrook aanwezig. Auto's moeten uitwijken over de fietsstrook.

Hoe veilig vindt u weg A? *

	1	2	3	4	5	6	7	8	9	10	
Niet veilig	○	○	○	○	○	○	○	○	○	○	Heel veilig

Weg B: smalle weg buiten de bebouwde kom met tweerichtingsverkeer. Er is een verhoogde scheiding in het midden waar over gereden kan worden. Brede auto's passen niet op één strook en moeten de middenberm gebruiken. Er zijn fietsen als markering op het asfalt aangebracht.



Hoe veilig vindt u weg B? *

	1	2	3	4	5	6	7	8	9	10	
Niet veilig	○	○	○	○	○	○	○	○	○	○	Heel veilig

Welke weg heeft uw voorkeur? *

Hoe meer richting 1 of 6, hoe sterker de voorkeur

	1	2	3	4	5	6	
Weg A	○	○	○	○	○	○	Weg B

Waarom heeft deze weg uw voorkeur? *

- ☐ Auto's gebruiken de fietsstrook niet als er geen tegenliggers zijn (Weg A)
- ☐ Het is duidelijk dat er fietsers aanwezig zijn door de fietsstrook (Weg A)
- ☐ De hele weg is ingericht voor fietsers (weg B)
- ☐ Tegenliggers zullen verder van je vandaan rijden door de scheiding (weg B)
- ☐ Anders: ____________

Voorkeur en gevoel van veiligheid fietsers

Feedback en commentaar

Heeft u nog algemene feedback of commentaar over dit onderzoek?

Jouw antwoord ____________

B. The survey in English

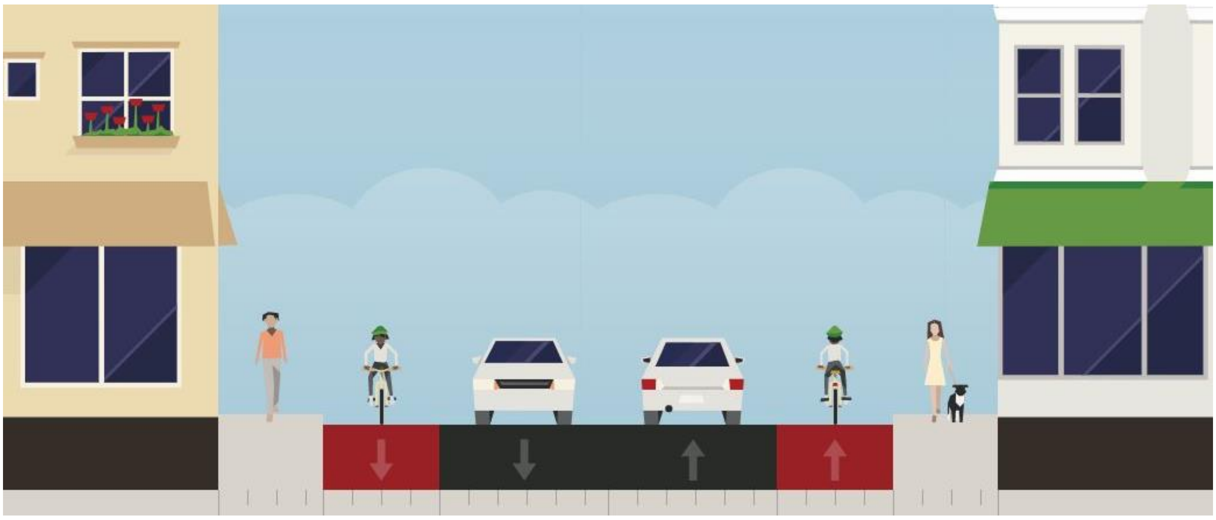
Section one

1. What is your age? (open question)
2. Which municipality is your municipality of residence? (all municipalities in NL selection)
3. Do you own a bike? (yes or no, survey still continuous if they do not own a bike)
4. How often in a week do you cycle? (before COVID-19) (never, less than once a week, 1-2, 3-5, almost every day)

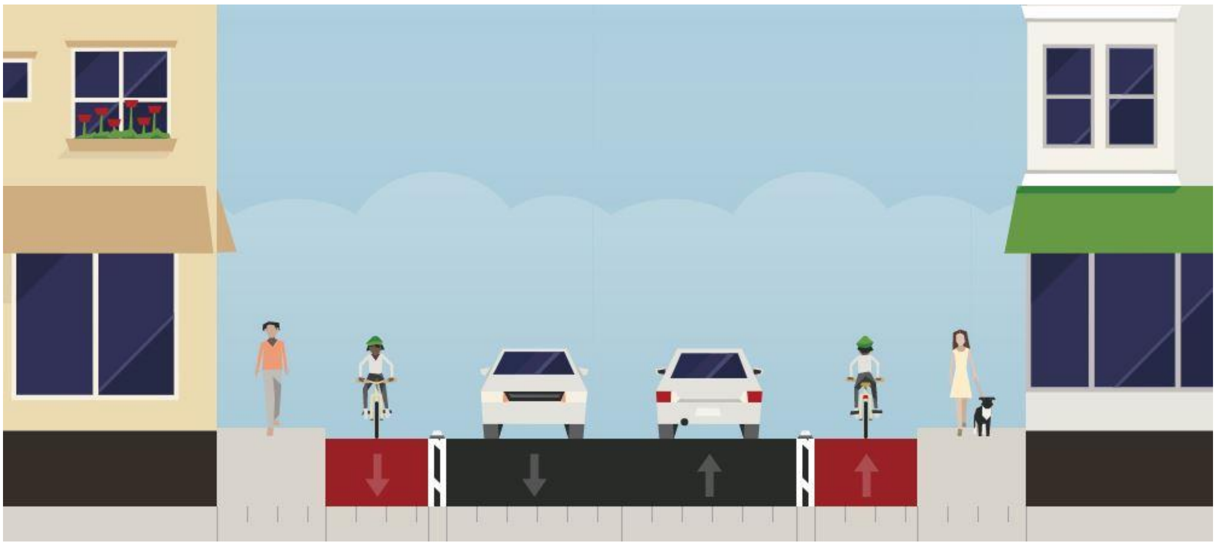
Section two

Question 1 of 6

Road A: A broad bicycle lane for two cyclists without separation. Cars and cyclists can use each other’s lanes to pass other users.



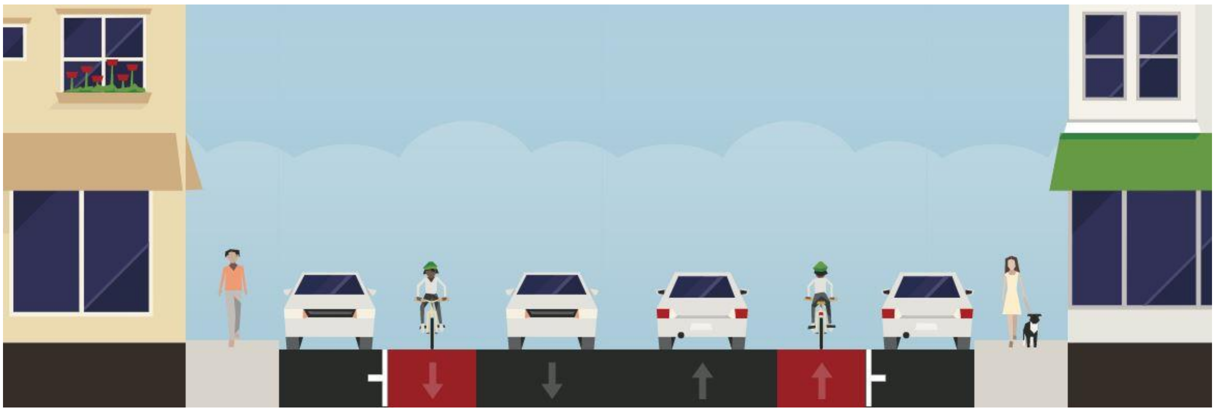
Road B: A narrower bicycle lane with a raised separation between car and bicycle. They cannot use each other’s lanes.



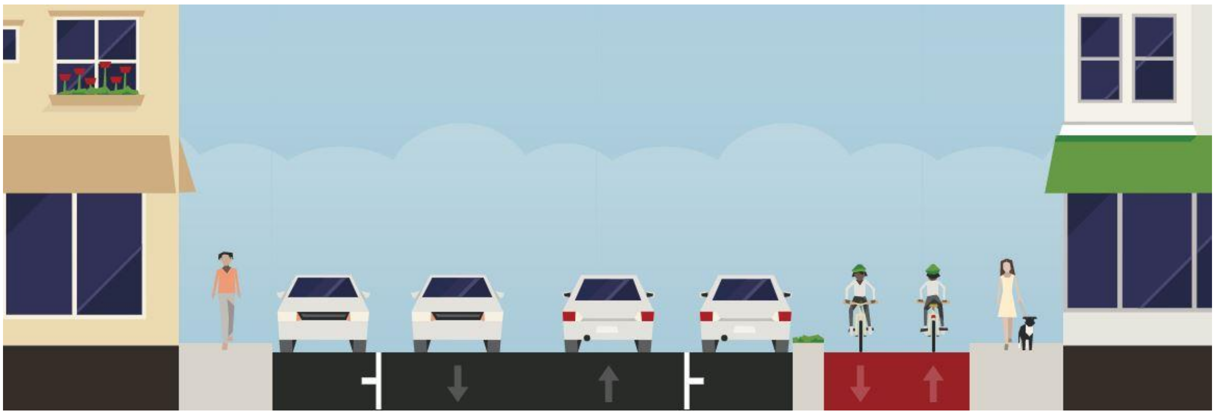
1. How would you rate the safety of cross-section A? (scale 1=not safe to 10=very safe)
2. How would you rate the safety of cross-section B? (scale 1=not safe to 10=very safe)
3. Which cross-section do you prefer (A or B) (scale 1=road A to 6=road B)
4. Why has this road your preference?
    a. The bicycle lane is wide enough for two cyclists (road A)
    b. Cyclists can pass others via the car lane (road A)
    c. Cars cannot enter the bicycle lane (road B)
    d. A bicycle lane for one cyclist is wide enough (road B)
    e. Other… (open question)

Question 2 of 6

Road A: A bicycle lane wide for one cyclist with parking facilities. Cyclists can use the car lane for passing each other.



Road B: A narrow bidirectional bicycle lane. You must pass by driving in the lane of different direction. Bicycle and car are separated. Parking facilities are next to the car lane.

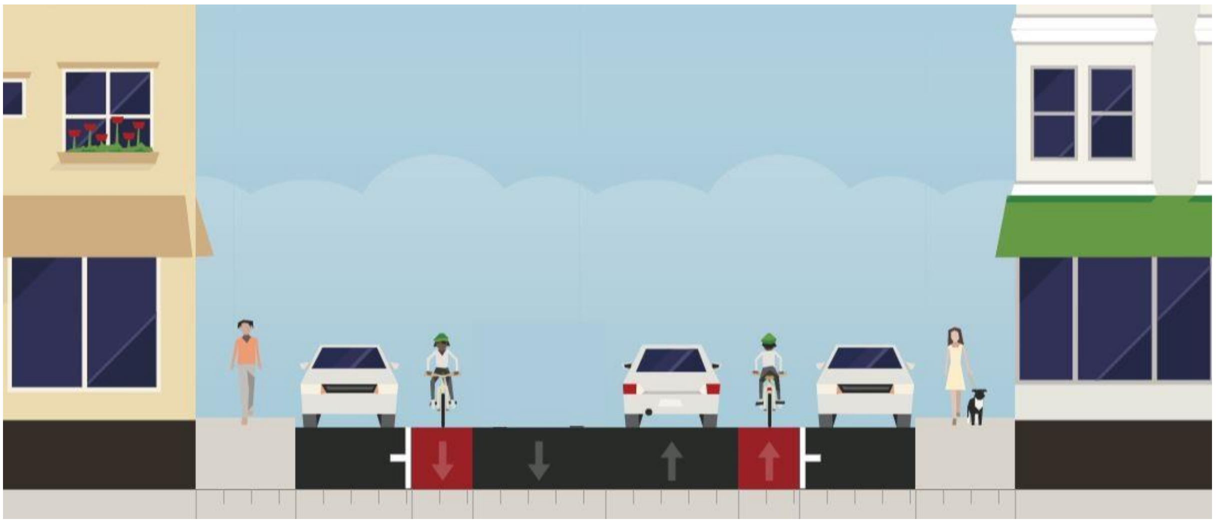


1. How would you rate the safety of cross-section A? (scale 1=not safe to 10=very safe)
2. How would you rate the safety of cross-section B? (scale 1=not safe to 10=very safe)
3. Which cross-section do you prefer (A or B) (scale 1=road A to 6=road B)
4. Why has this road your preference?
    a. The bicycle lane is wider (road A)
    b. Cyclists can pass others via the car lane (road A)
    c. Cyclists do not interact with parking cars anymore (road B)
    d. Cyclists and cars are fully separated (road B)
    e. Other… (open question)

Question 3 of 6

Road A: Bidirectional traffic with parking facilities. The bicycle lane is wide enough for two cyclists. Cars must use the bicycle lane if there is an oncoming car.

Road B: Same width as road A. The bicycle lane is the minimal width for one cyclist. Passenger cars can pass each other without using the bicycle lane. Broad cars must still use the bicycle lane.



1. How would you rate the safety of cross-section A? (scale 1=not safe to 10=very safe)
2. How would you rate the safety of cross-section B? (scale 1=not safe to 10=very safe)
3. Which cross-section do you prefer (A or B) (scale 1=road A to 6=road B)
4. Why has this road your preference?
    a. The bicycle lane is wide enough for two cyclists (road A)
    b. The bicycle lane is more present (road A)
    c. Cars do not have to pass each other via the bicycle lane (road B)
    d. The road can be used by cyclists (road B)
    e. Other… (open question)

Question 4 of 6

Road A: Broad bicycle street with cars as guest. Bidirectional. The marking in the middle is slightly elevated but still passable by bicycle and car.

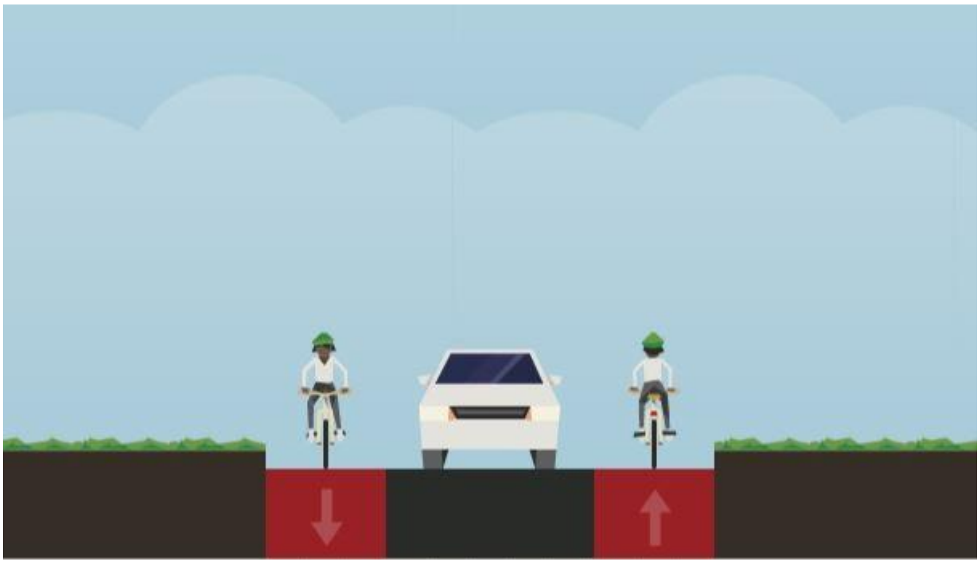
Road B: The same width as road A. Bidirectional. Cars must use the bicycle lane if there is an oncoming car. The bicycle lane is wide enough for one cyclist.

1. How would you rate the safety of cross-section A? (scale 1=not safe to 10=very safe)
2. How would you rate the safety of cross-section B? (scale 1=not safe to 10=very safe)
3. Which cross-section do you prefer (A or B) (scale 1=road A to 6=road B)
4. Why has this road your preference?
    a. The priority lies by the cyclists in the profile (road A)
    b. Cars are guests on the road so act more careful (road A)
    c. It is clears where cars are supposed to ride (road B)
    d. There is less chance on unpredictable driving behaviour (road B)
    e. Other… (open question)

Question 5 of 6

Road A: Narrow road outside the build-up area with bidirectional traffic. There is no separate bicycle lane present.

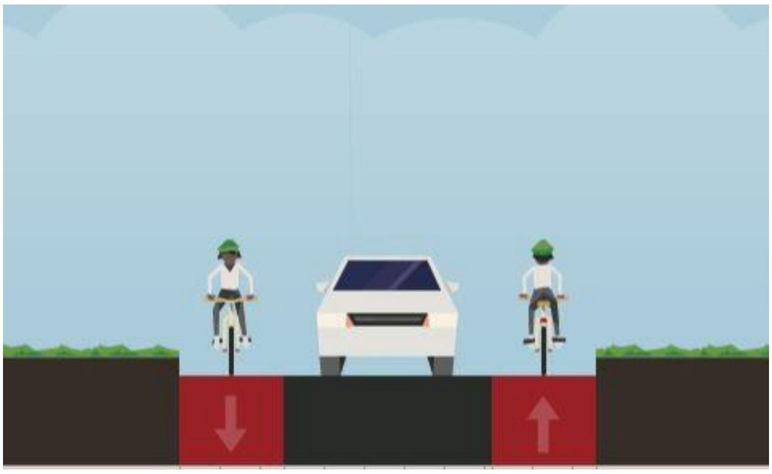
Road B: Narrow road outside the build-up area with bidirectional traffic. The bicycle lane is present. Cars must use the bicycle lane if there is an oncoming car.



1. How would you rate the safety of cross-section A? (scale 1=not safe to 10=very safe)
2. How would you rate the safety of cross-section B? (scale 1=not safe to 10=very safe)
3. Which cross-section do you prefer (A or B) (scale 1=road A to 6=road B)
4. Why has this road your preference?
    a. Cars do not have to pass each other via the bicycle lane (road A)
    b. The road has the same colour asphalt (road A)
    c. It is clear that cyclists are present in the profile due to the bicycle lane (road B)
    d. Cyclists are getting more priority (road B)
    e. Other… (open question)

Question 6 of 6

Road A: Narrow road outside the build-up area with bidirectional traffic. The bicycle lane is present. Cars must use the bicycle lane if there is an oncoming car.



Road B: Narrow road outside the build-up area with bidirectional traffic. There is a raised separation I the middle of the road which can be used to drive on. The bicycle markings are put on the asphalt. Broad cars do not fit on a single lane.

1. How would you rate the safety of cross-section A? (scale 1=not safe to 10=very safe)
2. How would you rate the safety of cross-section B? (scale 1=not safe to 10=very safe)
3. Which cross-section do you prefer (A or B) (scale 1=road A to 6=road B)
4. Why has this road your preference?
    a. Cars do not use the bicycle lane when there is no coming traffic (road A)
    b. It is clear that cyclists are present in the profile due to the bicycle lane (road B)
    c. The road is focused on cyclists (road B)
    d. Oncoming traffic will drive further from a cyclist in the other direction (road B)
    e. Other… (open question)

Section 3

Do you have any general feedback or comments about the research? (open question)

C. Classification of municipalities

Very urban (1)	High urban (2)	Moderate urban (3)	Little urban (4)	Not urban (5)
Amstelveen	Alblasserdam	Albrandswaard	Aalsmeer	Aa en Hunze
Amsterdam	Alkmaar	Appingedam	Aalten	Achtkarspelen
Beverwijk	Almelo	Best	Altena	Alphen-Chaam
Delft	Almere	De Bilt	Asten	Ameland
Diemen	Alphen aan den Rijn	Blaricum	Barneveld	Baarle-Nassau
Dordrecht	Amersfoort	Bloemendaal	Beek (L.)	Beekdaelen
Eindhoven	Apeldoorn	Bodegraven-Reeuwijk	Beemster	Bergen (L.)
Gouda	Arnhem	Borne	Beesel	Borger-Odoorn
's-Gravenhage (gemeente)	Assen	Boxtel	Berg en Dal	Borsele
Groningen (gemeente)	Baarn	Bunschoten	Bergeijk	Bronckhorst
Haarlem	Barendrecht	Castricum	Bergen (NH.)	Buren
Hilversum	Bergen op Zoom	Culemborg	Berkelland	Coevorden
Leiden	Breda	Doetinchem	Bernheze	Dantumadiel
Leidschendam-Voorburg	Brunssum	Dongen	Beuningen	Dinkelland
Rijswijk (ZH.)	Capelle aan den IJssel	Duiven	Bladel	Eijsden-Margraten
Rotterdam	Deventer	Edam-Volendam	Boekel	Gulpen-Wittem
Schiedam	Ede	Enkhuizen	Boxmeer	Haaren
Tilburg	Enschede	Geertruidenberg	Brielle	Het Hogeland
Utrecht (gemeente)	Etten-Leur	Geldrop-Mierlo	Brummen	Hollands Kroon
Vlaardingen	Gooise Meren	Gilze en Rijen	Bunnik	Koggenland
Zoetermeer	Gorinchem	Goes	Cranendonck	Landerd
	Haarlemmermeer	Goirle	Cuijk	Leudal
	Harderwijk	Haaksbergen	Dalfsen	Lopik
	Heemskerk	Harlingen	Delfzijl	Loppersum
	Heemstede	Heerenveen	Deurne	Maasdriel
	Heerhugowaard	Heiloo	Doesburg	Maasgouw
	Heerlen	Heusden	Drechterland	Midden-Drenthe
	Den Helder	Hoogeveen	Drimmelen	Mill en Sint Hubert
	Hellevoetsluis	Kampen	Dronten	Molenlanden
	Helmond	Landgraaf	Druten	Mook en Middelaar
	Hendrik-Ido-Ambacht	Landsmeer	Echt-Susteren	Neder-Betuwe
	Hengelo (O.)	Lansingerland	Eemnes	Noardeast-Fryslân
	's-Hertogenbosch	Laren (NH.)	Eersel	Noord-Beveland
	Hillegom	Lelystad	Elburg	Olst-Wijhe
	Hoorn	Leusden	Emmen	Ooststellingwerf
	Houten	Loon op Zand	Epe	Opsterland
	Huizen	Meppel	Ermelo	Roerdalen
	IJsselstein	Midden-Delfland	De Fryske Marren	Schiermonnikoog
	Katwijk	Nijkerk	Gemert-Bakel	Schouwen-Duiveland
	Kerkrade	Noordwijk	Gennep	Sint Anthonis
	Krimpen aan den IJssel	Nuenen, Gerwen en Nederwetten	Goeree-Overflakkee	Sluis
	Leeuwarden	Oisterwijk	Grave	Staphorst
	Leiderdorp	Oldenzaal	Halderberge	Terschelling
	Lisse	Oostzaan	Hardenberg	Texel
	Maassluis	Oss	Hardinxveld-Giessendam	Tholen
	Maastricht	Ouder-Amstel	Hattem	Tubbergen
	Middelburg (Z.)	Rheden	Heerde	Tytsjerksteradiel
	Nieuwegein	Rijssen-Holten	Heeze-Leende	Veere
	Nijmegen	Sittard-Geleen	Hellendoorn	Vlieland
	Nissewaard	Smallingerland	Heumen	Waadhoeke
	Oegstgeest	Soest	Hilvarenbeek	West Betuwe
	Oosterhout	Stede Broec	Hoeksche Waard	West Maas en Waal
	Papendrecht	Stichtse Vecht	Hof van Twente	Westerkwartier
	Pijnacker-Nootdorp	Teylingen	Horst aan de Maas	Westerveld
	Purmerend	Tiel	Hulst	Westerwolde
	Ridderkerk	Uden	Kaag en Braassem	De Wolden
	Roermond	Uitgeest	Kapelle	
	Roosendaal	Uithoorn	Krimpenerwaard	
	Sliedrecht	Urk	Laarbeek	
	Veenendaal	Vaals	Langedijk	
	Veldhoven	Valkenswaard	Lingewaard	
	Velsen	Veendam	Lochem	

Very urban (1)	High urban (2)	Moderate urban (3)	Little urban (4)	Not urban (5)
	Venlo	Venray	Losser	
	Vlissingen	Vught	Medemblik	
	Voorschoten	Waalwijk	Meerssen	
	Waddinxveen	Wassenaar	Meierijstad	
	Wageningen	Weert	Midden-Groningen	
	Weesp	Westervoort	Moerdijk	
	Zaanstad	Westland	Montferland	
	Zandvoort	Wijchen	Montfoort	
	Zeist	Wijk bij Duurstede	Nederweert	
	Zutphen	Winterswijk	Nieuwkoop	
	Zwijndrecht	Woerden	Noordenveld	
	Zwolle	Wormerland	Noordoostpolder	
		Zevenaar	Nunspeet	
		Zuidplas	Oirschot	
			Oldambt	
			Oldebroek	
			Ommen	
			Oost Gelre	
			Opmeer	
			Oude IJsselstreek	
			Oudewater	
			Overbetuwe	
			Peel en Maas	
			Pekela	
			Putten	
			Raalte	
			Reimerswaal	
			Renkum	
			Renswoude	
			Reusel-De Mierden	
			Rhenen	
			De Ronde Venen	
			Rozendaal	
			Rucphen	
			Schagen	
			Scherpenzeel	
			Simpelveld	
			Sint-Michielsgestel	
			Someren	
			Son en Breugel	
			Stadskanaal	
			Steenbergen	
			Steenwijkerland	
			Stein (L.)	
			Súdwest-Fryslân	
			Terneuzen	
			Twenterand	
			Tynaarlo	
			Utrechtse Heuvelrug	
			Valkenburg aan de Geul	
			Vijfheerenlanden	
			Voerendaal	
			Voorst	
			Waalre	
			Waterland	
			Weststellingwerf	
			Westvoorne	
			Wierden	
			Wijdemeren	
			Woensdrecht	
			Woudenberg	
			Zaltbommel	
			Zeewolde	
			Zoeterwoude	
			Zundert	
			Zwartewaterland	

D. Tables of the significance tests

Mann-Whitney U test

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Mean safe	388	5.6234	.99197	2.17	10.00
Municipality	388	1,48	,500	1	2

Ranks

	Municipality	N	Mean Rank	Sum of Ranks
Mean safe	1	201	201,38	40477,50
	2	187	187,10	34988,50
	Total	388		

Test Statistics

	Mean safe
Mann-Whitney U	17410,500
Wilcoxon W	34988,500
Z	-1,254
Asymp. Sig. (2-tailed)	,210

Kruskal-Wallis H test

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Mean safe	388	5.6234	.99197	2.17	10.00
Group Age	388	3,79	1,715	1	7

Ranks

	Age Group	N	Mean Rank
Mean safe	1	43	233,23
	2	79	216,61
	3	38	208,53
	4	61	193,88
	5	98	175,54
	6	61	170,38
	7	8	122,31
	Total	388	

Test Statistics

	Mean safe
Kruskal-Wallis H	17,753
df	6
Asymp. Sig.	,007

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Mean safe	388	5.6234	.99197	2.17	10.00
Usage frequency	388	2,87	1,094	1	4

Ranks

	Usage frequency	N	Mean Rank
Mean safe	1	62	141,57
	2	73	196,12
	3	105	210,03
	4	148	204,85
	Total	388	

Test Statistics

	Mean safe
Kruskal-Wallis H	17,115
df	3
Asymp. Sig.	,001

Wilcoxon signed-rank test

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
RoadA1	388	6,02	1,702	1	10
RoadA2	388	4,87	1,793	1	10
RoadA3	388	4,33	1,937	1	10
RoadA4	388	6,37	2,072	1	10
RoadA5	388	3,50	1,786	1	10
RoadA6	388	5,78	1,602	1	10
RoadB1	388	7,42	1,597	1	10
RoadB2	388	7,89	1,554	1	10
RoadB3	388	5,17	1,774	1	10
RoadB4	388	5,07	1,826	1	10
RoadB5	388	6,26	1,513	2	10
RoadB6	388	4,80	1,932	1	10

Ranks

		N	Mean Rank	Sum of Ranks
RoadB1 - RoadA1	Negative Ranks	71	159,26	11307,50
	Positive Ranks	283	182,08	51527,50
	Ties	34		
	Total	388		
RoadB2 - RoadA2	Negative Ranks	19	113,50	2156,50
	Positive Ranks	351	189,40	66478,50
	Ties	18		
	Total	388		
RoadB3 - RoadA3	Negative Ranks	92	132,15	12158,00
	Positive Ranks	216	164,02	35428,00
	Ties	80		
	Total	388		
RoadB4 - RoadA4	Negative Ranks	256	177,53	45446,50
	Positive Ranks	83	146,79	12183,50
	Ties	49		
	Total	388		
RoadB5 - RoadA5	Negative Ranks	13	95,15	1237,00
	Positive Ranks	356	188,28	67028,00
	Ties	19		
	Total	388		
RoadB6 - RoadA6	Negative Ranks	227	174,21	39545,50
	Positive Ranks	95	131,13	12457,50
	Ties	66		
	Total	388		

Test Statistics

	RoadB1 - RoadA1	RoadB2 - RoadA2	RoadB3 - RoadA3	RoadB4 - RoadA4	RoadB5 - RoadA5	RoadB6 - RoadA6
Z	-10,534	-15,692	-7,534	-9,274	-16,123	-8,188
Asymp. Sig. (2-tailed)	,000	,000	,000	,000	,000	,000

E. Personal motivation

From the age of 12, I cycled 14 km to school every day from Monster to The Hague. Although you would expect that the shortest route is the one to use, this was not the case. Every person I know had its own preference on the best route to school. Even if they lived in the same street. I changed routes every few months so that it would stay interesting to ride to school and back every day. What I discovered is that every route had its benefits and downsides. Could you pass people easily, is the road separated for different modes of traffic, the number of interchanges and paving type.

When I started studying in Delft in 2018, I experienced the same phenomenon. This time the route was about 18 km long and for the most part going through the green houses. These are very different from the cycle paths in the urban The Hague but still had many different forms. Now I live in Delft, and I do not have to travel large distances anymore, but the bicycle is still in use every day.

Because of the many kilometres travelled by bicycle I want to try to find the best cross-section for cyclists in subjective safety and preference. With this study I want to understand why I have this preference as well and how this relates to the others and objective safety.

Figure 9: Locations left Monster, top school The Hague and right TU Delft (Google Earth, 2021)