THE IMPORTANCE OF CONTEXT FOR THE PERCEIVED CYCLING SAFETY

A RESEARCH INTO HOW URBAN AND RURAL CONTEXTS IMPACT THE PERCEIVED SAFETY DIFFERENTLY

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Abstract:

In order to improve the modal share of cyclists recent research has shown that perceived safety has a larger impact on mode and route choice than objective safety. However, a lot of research about perceived safety is done in an urban context. Therefore, this research aims to find out if people from rural and urban contexts see the perceived safety differently and if it impacts their mode and route choice. This was done using a questionnaire with the program Maptionnaire together with RTV Noord and analysed using a spatial analysis, binary regression, and a word count analysis. These analyses show that people from urban and rural contexts chose different built environment types as their most unsafe spots for cycling. Even though there is a difference in what kind of built environment they chose as most unsafe, according to the statistical analysis the perceived built environment is only impacted by the socio-demographic characteristics and not by the urban/rural context. The urban and rural contexts on the other hand mostly impact the perception of the different traffic modes. This insight that the urban and rural contexts have an impact on the perceived danger of different modes can be used by policymakers in order to make more area-specific plans that deal with the impact of these perceived dangerous modes on people's mode and travel behaviour.

Keywords: Perceived accessibility, Perceived safety, Rural/urban context, Socio-demographic characteristics

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1. Introduction

Countries worldwide are trying to increase the modal share of cycling to improve physical health and reduce the environmental impact of travelling to destinations (Interreg, 2020). An additional benefit is that bicycles are more space efficient compared to cars as it uses less space both on the road and when it is parked (Götschi et al., 2018) Due to this space efficiency of bicycles, more people can fit on one road section, which can lead to less congestion in cities. Furthermore, the lower space requirement for parking bicycles makes higher densities possible (Lee & March, 2010). These benefits of increasing the modal share of cycling lead to a higher quality of life in the surrounding area, as people are more healthy, there is less air pollution present, and the increase in density and lower congestion decreases the travel time of cyclists compared to a car-centric city (Yin et al., 2020). In order to incentivize people to cycle municipalities create bicycle lanes in order to protect cyclists from other transport modes because the safety of a mode is key in order to get people to use them (Branion-Calles et al., 2019). However, only building bicycle lanes is often not enough to increase the modal share of cycling in municipalities, as it often only focuses on the objective side of safety and not on the subjective side (Jamei et al., 2022). Recent research has shown however that the perceived safety is more important for incentivizing and deterring people from cycling compared to the objective definition of safety (Budd & Mumford, 2006; Ma & Dill, 2017). Additionally, in order to increase the modal share of cyclists planners should also use the concept of perceived accessibility which is closely connected with perceived safety. The reason for this is that people who perceive a specific mode as accessible, will also more likely use that specific mode of transport (Jamei et al., 2022). Not only leads to accessibility to higher usage of a specific mode it can also increase the attractiveness for businesses to settle and can increase the economic growth at those places with a high accessibility across different traffic modes (Rokicki & Stępniak, 2018). This attention to increasing the objective accessibility in municipalities also leads to more attention to the perceived accessibility in regions. It started with the perceived accessibility of disabled people, but nowadays increasingly more research is done about the perceived accessibility of active travel modes, especially cycling as not everyone is able to drive a car (Giles-Corti et al., 2016). However, most reports are still made with the objective mathematical definition of accessibility (Jamei et al., 2022). The objective variant of accessibility only focuses on the presence of cycling infrastructure and how easy it is to get to a destination. It ignores however the perceived safety of cycling in the region, which is important for mode and route choice besides personal preference (Jamei et al., 2022). Therefore, in order to increase the modal share of cycling, policymakers and academics should not only focus on objective safety but also on perceived safety as both are interrelated for the mode and route choice (Budd & Mumford, 2006). However, in order to increase the modal share of cycling more research is needed, as it is still quite unclear what has an impact on the perceived safety as it is quite context-specific (Blitz, 2021).

Even though perceived safety has been getting more attention recently both in policy documents and academic literature it is mostly done for urban areas, rural areas on the other hand are hardly getting attention. According to Harms et al. (2014), this is due to the larger population in urban areas. So more people are being affected and mode interaction is there also the highest, which is a major factor for a reduction in perceived safety (Fitch et al., 2022). Less attention is paid to rural areas as they have a lower population density, which leads to lower vehicle interaction (Tao et al., 2019). However, in rural areas cycling infrastructure often has a lower quality compared to cities. For example, rural areas often have less amount of bicycle lane kilometres compared to more urban areas (CBS, 2022) which is also a major factor for the perceived cycling safety in the area (Branion-Calles et al., 2019.). These differences in context between rural and urban areas can lead to a difference in perceived safety but also on perceived cycling accessibility such as route and mode choice. Therefore, this research aims to find out how the rural and urban contexts impact the perception of cycling safety and their route and mode choice. A better understanding of the differences between rural and urban areas can shed more light on how the context impacts both the concepts of perceived safety and perceived accessibility. This understanding can lead to more area-based approaches in dealing with perceived safety and accessibility, as the rural context might need different measures compared to urban areas.

This has led to the following research question:

> What attributes of safety are perceived as most important In urban and rural areas by inhabitants province of Groningen?

And the following sub-questions:

- Sub-question 1: How do people from urban and rural areas perceive cycling safety differently?

- Sub-question 2: Does the difference in perceived safety between urban and rural people lead to a difference in perceived accessibility?

- Sub-question 3: How do the socio-demographic characteristics of people impact the perceived safety and perceived accessibility in rural and urban regions?

2. Theoretical framework

2.1 Perceived safety

Perceived safety is the concept of how safe or unsafe people feel at a certain spot (Blitz, 2021). Unsafety can have different sources, one of them is due to criminality or similar actions done by people (Jamei et al., 2021). The other source of unsafety on the street is due to dangerous situations created by traffic modes such as collisions (Nuñez et al., 2018). Both sources impact the perceived accessibility (Jamei et al., 2021), however, in the context of this research, only the unsafety created by traffic modes will be used, as this is more relevant for this research.

The perceived safety is not directly correlated with the objective cycling safety. A reason for this is that an increase in objective safety does not necessarily increase the perceived safety, because the perception of safety is impacted by a lot more factors than just the amount of collisions measured by the objective definition of safety (Elvik & Bjørnskau, 2005). This is also explained by Ma and Dill (2017) in their research, where they explain that this is due to that people remember unsafe spaces better than safe sections of roads. Another reason is that perceived safety is subjective which means that it cannot be rational, thus socio-demographic factors play a major role in their perception of safety (Elvik & Bjørnskau, 2005). A major factor that plays with people's perception is how often they cycle. People who cycle more often view their environment as more bikeable and safer compared to people who do not cycle often (Ma and Dill, 2017). People are also poor in estimating risks, as they often overestimate the risks of collision of active travel modes (Elvik & Bjørnskau, 2005), which is a major barrier to a mode switch to active travel modes (Gössling & McRae, 2022). Besides mode choice, the perceived safety is also a major factor for route choice, as people take significant detours to avoid certain dangerous places (Gössling et al., 2019). Ma and Dill (2017) build upon this, where they explain that perceived safety is more important than objective safety for mode and route choice.

According to Blitz (2021), several factors impact the perceived safety which are socio-demographic characteristics, the perceived design of cycling infrastructure, the traffic intensity, and the difference in traffic modes. This research will use the same factors to analyse the perceived cycling safety both in rural and urban areas.

The difference between perceived and objective cycling accessibility

The design of the cycling infrastructure is an often used method to make places more accessible for cyclists and ultimately increase the modal share of bike users. Measuring accessibility is often done using the objective method which means that only the presence of infrastructure for that specific mode is used to analyse the ease of getting from one place to their destination (Jamei et al., 2022). This means that the presence of infrastructure increases the ease of reaching the destination according to the objective method, even when people take a detour because, for example, they do not feel safe cycling at that specific infrastructure. Therefore Fitch et al. (2022) argue that policymakers should not only look at the objective accessibility but also at the perceived accessibility in order to increase the modal share of bikes. (Fitch et al., 2022). This means not only looking at the presence of the infrastructure but also at the perceived design of the infrastructure as it has a large impact on both the perceived safety and subjective accessibility (Ma and Dill, 2017).

The design of cycling infrastructure

An often-used method by policymakers to make cycling infrastructure better is expanding the bicycle lane network. This can be done with several methods, one method that is used in a lot of places without a lot of space is the painted bicycle lane at the sides of the route without a barrier between cars and cyclists (Branion-Calles et al., 2019). This is a cost-effective and easy way of increasing the bicycle road network, but a lot of people perceive these bicycle lanes as unsafe due to that there is still a large number of interactions with other traffic modes with higher speeds such as cars (Chataway et al., 2014; Branion-Calles et al., 2019). The painted bicycle lane, while easy to implement and cost-effective, does not have a lot of impact on the perceived accessibility of cyclists and is also less likely to increase the modal share due to that it only increases the perceived safety by a low amount compared to separated bicycle lanes (Branion-Calles et al., 2019; Manton et al., 2016).

Besides painted bicycle lanes, there is also a separated bicycle lane (Branion-Calles et al., 2019). These bicycle lanes have a boundary between cars and cyclists. This can be bollards between the bicycle path and car road, another option is complete separation (Ohlund et al., 2021). Both options are perceived as safer compared to the painted bicycle lane or mixed traffic (Chataway, 2014). However, complete separation between the bicycle lanes and car roads is seen as more safe compared to the bollards because there is more space between cars and cyclists (Ohlund et al., 2021) Nonetheless, only building separated bicycle lanes is not enough in order to encourage cycling as it will not directly lead to an increase in perceived safety, especially in places that were previously seen as unsafe (Elvik & Bjørnskau, 2005). However, over time public perception of previously dangerous spots can shift, which can change the route choice of cyclists to the new bicycle path (Philips et al., 2011).

The presence of one-way or two-way bicycle lanes is important for both the objective and subjective safety (Thomas and DeRobertis, 2013). As two-way bicycle lanes lead to more collisions compared to single-way bicycle lanes due to the increase in vehicle interaction in opposing directions (Thomas and DeRobertis, 2013). The width of the road is important for the perceived safety of both two-way and one-way roads as more space to cycle on means that there is a lower amount of close vehicle interactions between cyclists. One-way traffic bicycle lanes are often smaller which can lead to a lower perceived safety as it leaves less room for manoeuvres and overtaking (Von Stülpnagel and Binnig, 2022).

The impact of the design of intersections on perceived safety

The design of intersections is also important for improving the perceived safety of cyclists because at intersections the risk of cyclists getting into a collision is higher compared to shared and separated bicycle paths (Dozza and Werneke, 2014). A reason for this are the traffic rule violations by both motorized traffic and cyclists, for example riding through a red traffic light (Gavriilidou et al., 2021). Another reason are the sharp turns, and a lack of road markings at intersections (Wijlhuizen et al., 2016). However, the main cause of the increased risks is the increase in interaction not only between motorized traffic and bicycles but also between cyclists and other cyclists (Gavriilidou et al., 2021). At intersections without traffic lights, especially T-intersections both cyclists and cars driving on the straight road have a high feeling of priority perception and are less often to yield even when they have to according to traffic laws, which results in a higher amount of collisions for both cyclists and cars (Costa et al., 2019).To increase the objective cycling safety Wexler and El-Geneidy (2017) advise therefor a separation between cyclists and cars at intersections which in turn can increase the perceived safety. Even when cyclists and motorized traffic share the same road, measures such as road colouring at intersections, and preferential road spaces for cyclists lead to a higher subjective safety perception as it provides guidance for cyclists at intersections (Autelitano and Giuliani, 2021). These visual indicators for cyclists also lead to a change in behaviour by car drivers because according to Fernández-Heredia et al. (2015), visual indicators will lead to a lower encroaching speed for cars and drivers are more likely to yield to the cyclist. However, even though such visual indicators improve the perceived safety for cyclists at the intersection and it changes the driving behaviour of cars, the impact on the objective safety is more mixed as cyclists drive more recklessly compared to an intersection without such visual indicators (DiGioia et al., 2017). Also, research has shown that increasing the number of bike facilities such as preferential spaces can also lead to a reduction in the perceived for some people. The reason for this is that the presence of biking facilities at intersections reinforces their idea that this specific intersection is considered dangerous and in their opinion, these measures do not enough to solve the safety problem (Parkin et al., 2007). The presence of a roundabout is important for the perceived safety, as the roundabout leads to lower vehicle speeds compared to signalized and unsignalized intersections (DiGioia et al., 2017). But the design of the roundabout is more important for both the objective and subjective safety than the presence of one. Roundabouts with bike lines inside the roundabout lead to more collisions and more interactions between cars and bicycles compared to segregated bicycle lanes on the outside of the roundabout (DiGioia et al., 2017).

Maintenance of roads

The perceived maintenance of bicycle lanes matters, lanes with potholes in them are often seen as dangerous. Not only because potholes and cracks can create dangerous situations, but it also shows cyclists that the government does not really pay a lot of attention to the quality and maintenance of the cycling infrastructure in their area, which can create disincentives to take the bike, especially for people that do not cycle or who do not cycle often (Gadsby et al., 2022). The impact of maintenance on the perceived safety of cyclists also depends on the type of bicycle path. In mixed traffic or unseparated bicycle lanes, people feel more unsafe when facing potholes or cracks compared to separate bicycle lanes. According to Gadsby et al. (2022), the reason for this difference is that on mixed roads and unseparated bicycle lanes cyclists must pay more attention to the surrounding traffic which leads to less time to identify potholes and large cracks. The shorter identifying time will lead to those potholes appearing more suddenly and results in that cyclists having a lower reaction time to make a manoeuvre to avoid potholes compared to unseparated roads (Gadsby et al., 2022). Not only the presence of potholes or cracks has an impact on the perceived safety, but also the presence of snow and ice on bicycle lanes leads to a reduction in perceived safety not only because it gives the notion that the roads are not well maintained but it also increases the risk of accidents, not only does the presence of snow and ice increase the chance of an accident but also the severity of it (Filipović et al., 2022). Similarly, less maintained roads also increase the chance of accidents and collisions (Filipović et al., 2022) not only due to driving into a crack in the road or a pothole but also due to the attention paid to avoiding them, which can lead to less attention to the surrounding context and fellow road users (Gadsby et al., 2022).

Traffic intensity

The intensity of traffic matters, because a higher traffic intensity also increases the number of dangerous situations (Kerr et al., 2016). Especially large amounts of motorized traffic lower the perceived safety (Fitch et al. 2022). Fitch et al. (2022) explain in the case of cyclists that this is due to the speed difference. However, large amounts of the same mode of transport increase the perceived safety. The reason for this is that other modes of transport have to take these groups into account and are more alert for collisions (Aldred and Jungnickel, 2014). This is confirmed by Jacobsen (2015) where they prove that more cyclists will lead to a lower amount of collisions with cars. However, there is a certain tipping point, where cyclists feel more unsafe in larger groups. The reason for this is that cyclists have less space to cycle and react in large groups. (Gössling and McRae, 2022).

Modes of transport

Cycling is often perceived as one of the most dangerous methods to travel. A major reason for this is the close proximity to other traffic which decreases the perception of safety (Lawson et al., 2013). Not only collisions but also near misses situations have a major impact on the perceived safety of cyclists, the reason for this is that near misses still psychologically resemble crashes. These near misses with other modes of transport can have a bigger impact on the perceived safety compared to collisions because near misses occur a lot more often and with locations with poor cycling infrastructure even multiple times during the same trip (Sanders, 2015). The car is often seen by cyclists as the most dangerous mode for them due to multiple reasons. A major reason is the speed difference between the cyclist and the car. The second reason is that car drivers drive often less attentively compared to cyclists because a collision with a cyclist does not have as much of an impact on them (Waitt et al., 2021). The Netherlands dealt with this second reason by making drivers accountable when hitting a cyclist because a collision is for the cyclist significantly more dangerous compared to the driver. This has led to that car drivers paying more attention to other modes of transport compared to some other countries (Pucher & Buehler, 2008). The difference in speeds plays a major role in the perceived safety of cyclists, which is also shown by the research done by Popovich et al. (2014) which showed that the ease of reaching a higher speed has an impact on the perceived safety of both users of e-bikes and those that do not use an e-bike. The reason for this is that due to the ease of accelerating leads to higher speeds on an e-bike, which according to cyclists leads to more collisions and severity of these. However, research on the impact of e-bikes on the occurrence and the severity is inconclusive, as there are multiple studies that show there is a relation, but there are also a lot of studies that do not show this relationship (Haustein & Møller, 2016). This shows that the perception of safety when driving and encountering e-bikes is different from the objective safety, due to personal experiences and characteristics (Haustein & Møller, 2016). An example of this is that people who use an E-bike but keep the same speed and driving style as when they used a normal bike will feel safer when cycling when using an E-bike compared to a normal bike. A key reason is that e-bike users experience that other people, using other modes of transport, often underestimate the speed of cyclists leading to a lot of dangerous situations which involve both collisions and near misses (Haustein & Møller, 2016). The near misses do impact the perceived safety as mentioned before but it is not included in the objective safety statistics, which can explain this difference in perceived and objective safety (Sanders, 2015).

Pedestrians are often seen as less dangerous compared to cars by cyclists. They are however often seen as a major source of frustration by cyclists, comparable to car drivers and cyclists. The major reason for this is the difference in speed between the two traffic modes. Pedestrians are slower than bikes, which leads to that cyclists' need to adapt their speed and flow to pedestrians. Another source of frustration is pedestrians that walk in their path even when the road is shared between cyclists and pedestrians (Waitt et al., 2021).

Even though the speed difference is an important factor in decreasing the perceived safety, also the weight and the size of a vehicle has an impact on the perceived safety. Larger and heavier vehicles often lead to more severe collisions for the cyclists compared to vehicles that are smaller and lighter

(Meredith et al., 2020). The reason for this is that larger vehicles can create often more energy crashes for example throwing cyclists off their bikes compared to smaller vehicles which often create more lower energy crashes such as loss of traction or falling off their bike (Meredith et al., 2020). Comparably, collisions between two cyclists or between pedestrians and cyclists often lead to less severe collisions compared to cars, while they might occur more often. (Filipović et al., 2022). However, it must be noted that collisions between cyclists are often not reported, especially the ones with less severe collisions, thus at the moment there is no objective proof that less severe collisions occur more often, but this is an assumption made by most research projects (Filipović et al., 2022). This perception of more severe collisions with motorized traffic compared to crashes with other cyclists or other pedestrians even though they occur less often has a larger impact on the perceived safety of cyclists (Filipović et al., 2022).

2.2 Perceived accessibility

Boisjoly and El-Geneidy frame accessibility as “the ease of reaching destinations” (Boisjoly & El-Geneidy, 2017, p. 38). Important factors for accessibility are the built environment such as the location of the destination, but also transport options, and the necessary infrastructure (Handy, 2020). This is often analysed empirically using indicators such as travel costs and travel time using analytical tools such as GIS (Jamei et al., 2022). The other way of analysing accessibility is by researching the perception people have of accessibility. This method is used less often than objective accessibility in policy documents, but it is slowly changing as inclusiveness for everyone becomes an important point on the agenda of many cities. (Jamei et al., 2022). The objective method of analysing is increasingly seen as a relic of the past with a large focus on the economy (Jamei et al., 2022).

Similarly to the objective measurement of accessibility perceived accessibility can also include factors such as perceived travel time and perceived travel costs. However, it can also include other factors such as route choice and mode choice. Not having the option to use a specific mode of transport can impact the perceived accessibility, similar for route choice. Both are impacted by perceived safety as mentioned before because perceived safety can impact the route choice as people often avoid dangerous places or other use of other modes due to the perception of unsafety (Ma and Dill, 2017). Similarly to objective accessibility, the perceived accessibility can differ between different modes of transport, (Scheepers et al., 2016). Using a car will less likely lead to a change in route due to dangerous situations compared to more active modes of travel such as cycling (Waitt et al., 2021).

The concept of bike-ability is closely connected to accessibility, as it is defined as the ease of getting around when riding a bike(Ma and Dill, 2017; de Vos et al., 2023). Similar to accessibility, bikeability can be measured both objectively and in the perception of people on the ease of cycling at that location(Ma and Dill, 2017). However compared to accessibility, there is less focus on transport costs and travel time, but more on how easy it is to cycle to a specific location. This leads to that a large focus of bikeability is the quality of infrastructure meant for their mode of transport and the proximity of the destinations (de Vos et al., 2023). In this research, only the quality of the infrastructure and people’s perception of it is researched as it is related to shared safety. The concept of proximity on the other hand is therefore omitted from this research even though it has an impact on the modal share of bicycles. The quality of infrastructure for their own mode of transport is not only important for the perceived safety as explained earlier (Blitz, 2021), but it also leads to the idea that you are allowed to use that mode of transport at that location, which is an important factor for bikeability. If there is no infrastructure or the design for a specific mode is poor, that will lead to a feeling of unwelcomeness. This feeling of unwelcomeness on a road proves to be a significant obstacle of using that piece of the road even when it is allowed. This can impact the perceived accessibility of that road section quite a lot, as people will avoid that section (Suarez-Balcazar et al., 2020). This also means that higher quality of infrastructure for active travel modes will lead to more welcomeness using active travel modes. This not only increases perceived accessibility but also both the perceived and objective bike-ability (Suarez-Balcazar et al., 2020). Not only does the quality of the infrastructure impact the welcomeness of a road section, but also the condition of the pavement, traffic intensity, and the perception of the built environment has an impact on bike-ability (Suarez-Balcazar et al., 2020). In addition to the physical quality of the road, the presence of street lights near the bicycle lanes also has an impact on how inviting a place is as it not only increases the comfort of people cycling there but also it increases the safety of cyclists. Because people feel safer when they perceive that they are easily seen by other road users (DiGioia et al., 2017).

Some of these factors such as traffic intensity and the quality of the infrastructure are closely related to the perceived safety, but most of them are also important factors for the pleasantness of the trip, of which traffic safety is an important factor (Blitz, 2021). Roads that are inviting and where people feel welcome to drive are often also the most pleasant sections of roads, which leads to people being more likely to choose that route when cycling.

2.3 Rural and urban regions

The context between urban and rural differs, which can lead to a difference in the perceived safety and accessibility as these concepts are context-dependent (Blitz, 2021). Urban regions have a larger population density compared to rural areas, which results in more traffic movements and a larger variation in traffic modes compared to more rural areas (Tao et al., 2019). Also, the bicycle path density is often higher compared to rural areas, an explanation is that more people take to the bike due to the closer proximity to destinations in urban areas (CBS, 2022). Rural areas, on the other hand, have a smaller population density and a lower amount of kilometres of cycling lanes. As a result, the connectivity for cyclists is lower in rural areas, which leads to a lower modal share of cyclists compared to urban areas (Harms et al., 2014). Additionally in rural areas destinations are further away, which results in that rural people being more likely to take a car compared to other modes of transportation such as cycling (King et al., 2020; Harms et al., 2014). This is also shown in the difference in trip purpose, in urban areas, people are more likely to use the bike to commute, while people from rural areas use the car more often to commute (Harms et al., 2014). Interestingly, this is different for trips to an educational facility, as people from rural areas are more likely to use a bike to ride to educational facilities compared to people from urban areas. Other trip purposes are rather similar between urban and rural areas. While cycling toward educational facilities seems to improve in both urban and rural areas, other trip purposes seem to decline in rural areas while in urban areas the modal of bicycles for these trip purposes is increasing (Harms et al., 2014). This can be explained by the changing age composition of rural and urban areas. Younger people after graduating often move to cities and they are also the age group that uses the bike most often. Older people often stay behind in the rural areas and this age group uses the bicycle less, this explains the difference in modal share of cycling for the different trip purposes between urban and rural areas according to Harms et al. (2014).

e-bikes usage between rural and urban areas

Also, the usage of e-bikes differs between urban and rural areas. According to research done by Harms et al. (2014), e-bikes are more prevalent in rural areas. The explanation for this is that e-bikes make it easier to cover large distances by bike, which is helpful for rural areas as locations are more spread out compared to urban areas. Another explanation is the difference in age as explained before, older people often stay in rural areas while younger adults often move to cities. Because older people use an e-bike more often compared to younger people, which can explain the difference in e-bike use between rural and urban areas (Harms et al., 2014).

Another factor that impacts the bikeability in rural areas is the maintenance of the bicycle lanes, in rural areas bicycle lanes are often less maintained, and are less likely cleaned of snow and ice, due to the lower usage. Especially routes that are not used a lot, are often neglected as more attention is often paid to bicycle paths that are used more often, this leads to an increase in the chance of an incident on lower-used bicycle lanes (King et al., 2020).

2.4 Socio-demographic factors

Socio-demographic factors such as age and gender have a large impact on the perception of people. Elvik and Bjørnskau (2005) prove this in their research that men are bad at assessing risks as they often over or underestimate risks. Women are better at assessing risks as their assessment is closer to the objective risks compared to men. This also leads to that men often have a higher perceived safety of active travel modes compared to women (Elvik and Bjørnskau, 2005). This is also proven by research done by Fitch et al. (2022) who prove that women feel more unsafe compared to men on the same road section even when they have the same collision risk (Olsson and Elldér, 2023). According to Akgün-Tanbay et al. (2022), the reason for this is that women feel less safe when they come in contact with other traffic modes when cycling. However, the presence of a protected bicycle lane has a larger impact on the perceived safety of women compared to men (Guo et al., 2023). Women also often feel less comfortable when cycling due to this lower perceived safety, which leads to women being more likely to take another mode of transport such as the car (Fitch et al., 2022; Olsson and Elldér, 2023). The reason for this is that women are more risk-averse compared to men, which leads to that the perceived safety has a bigger impact on the perceived accessibility compared to men, as they are more likely to take another route or mode of transport (Olsson and Elldér, 2023)

Age also matters as older people often feel more unsafe when using E-bikes and normal bikes (Haustein and Møller, 2016). Especially, the higher speed and weight of e-bikes lead to a decrease in the perception of the cycling safety of older people compared to young people (Haustein and Møller,2016). Other research about the age effect on the perceived safety is still inconclusive as there are studies that show this effect and others do not (Guo et al., 2023) However, research has shown that older people are also less agile and have a higher reaction time, which makes them more vulnerable (Kaparias et al., 2012; Braver and Temple, 2004). Age also matters for trip purposes as younger people are more likely to use the bike daily for commuting, and going to shops while older people use the bike less and use it more for recreation compared to younger people (Harms et al., 2014).

The usage of different traffic modes also impacts perceived safety. People who only use the car, often see bikes as more dangerous compared to cyclists, even though cyclists are the ones experiencing the unsafe situations. In addition, people who cycle often also feel more safe using the bicycle and often see neighbourhoods as more bikeable compared to people who cycle less often (Ma and Dill, 2017). A Probable explanation is the experience in dealing with unsafe situations using a bike (Ma and Dill, 2017) and better preparation for these dangerous areas (Chataway et al., 2014).

The trip function also has an impact on the perceived safety. As people who cycle for recreation often do it at spaces that often have a lower traffic intensity compared to the cyclists that cycle for transport. (Poulos et al., 2017). This also means that they have fewer interactions with other traffic modes which increases the perceived safety of recreational cyclists (Poulos et al., 2017).

2.5 Hypothesis and conceptual framework

The theoretical framework leads to the following conceptual framework (see Figure 1) and hypotheses:

Hypothesis 1: Urban areas are more likely to find the factors of traffic intensity and interactions between different modes more important for the perceived safety compared to people from rural areas due to the higher population density. People from rural areas are on the other hand more likely to find the quality and the design of cycling infrastructure more important because rural areas often have less cycling infrastructure compared to urban areas.

Hypothesis 2: People from urban areas are more likely to use another route or use a different mode of transport compared to people from rural areas because urban areas provide more options for different traffic modes and other cycling routes due to the higher population density.

Hypothesis 3: Women are more likely to feel unsafe compared the men. Also, elderly people are more likely to perceive a road section as unsafe. Thus both elderly people and women will likely change their behaviour more compared to men and young people.

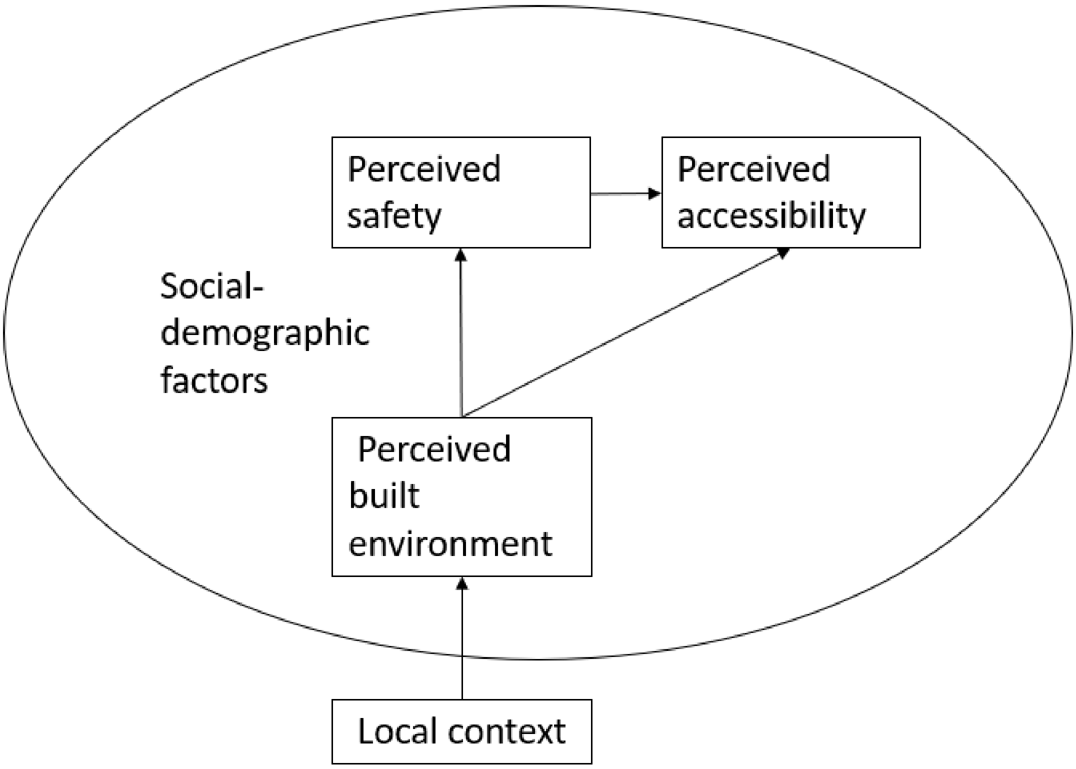

Figure 1: a conceptual framework

3. Methodology

The aim of this research is to find out if people from urban and rural areas perceive the cycling safety differently and if it impacts their cycling behaviour due to the different contexts in built-up areas. In order to find out the Maptionnaire tool was used as it allows spatial questions (Maptionnaire, n.d.), which was distributed by RTV Noord. This allowed the researcher to ask people about their unsafe places to cycle at. In the survey, people can pick a location on the map of the province of Groningen. This resulted in a pop-up about the questions about why they find it dangerous using the factors: the design of cycling infrastructure, traffic intensity, and traffic modes, and if it impacts their route and mode choice. All these questions in the pop-up uses a 5-point Likert scale from completely agree to completely disagree. This was done as according to Ma and Dill (2017) using a Likert scale is the best way to analyse people's perception of both accessibility and safety statistically. As this method allows people to voice their opinion, while still providing data that can be analysed statistically in order to make more generalized statements compared to interviews. This was done to analyse if there is a difference in the perception of safety between people from urban and rural areas as according to Blitz both concepts are context dependent (2021). In addition, socio-demographic characteristics for example age, and gender were asked as can be seen in Appendix 1. As these socio-demographic characteristics impact the perceived safety besides the local context (Blitz, 2021; Olsson and Elldér, 2023; Elvik and Bjørnskau, 2005), thus in order to analyse the perceived safety it is useful to include these characteristics in the analysis. Additional questions were asked about their trip purpose, how many times they ride their bike, and in what kind of context, because according to Ma and Dill (2017) experience when riding your bicycle leads to a higher perceived safety. As can be seen in Appendix 1 the questionnaire also asked additional questions such as their most safe place but this was not used for this research as it was relevant for the other partners that also used the data for their research.

3.1 The province of Groningen

In order to analyse these differences the province of Groningen was chosen. The reason for this is that the city of Groningen is often seen as one of the best cities to cycle in due to its extensive cycling services and infrastructure (Oog Groningen, 2022) with 61% of trips done by bike (Van der Zee, 2015). The city of Groningen has a long history of promoting bikes in the city, with the Groningen Verkeer circulatie plan as its most well-known measure due to its large impact on the mobility in the inner city of Groningen. This Groningen circulatie plan implemented in 1977 divided the inner city into four zones, cars cannot move from one zone to another zone directly and have to use a detour. On the other hand, cyclists can move from one zone to the other zone, this led to that the modal share of bikes increased in the inner city, while the amount of trips done by car in the inner city was reduced (van der Zee, 2015). Another important factor is that the city of Groningen is relatively compact, which leads to short travel times which improves the modal share of bikes even further according to the municipality of Groningen in an interview done by the Guardian (Van der Zee, 2015). An important factor of the city of Groningen is that it is one of the student cities in the Netherlands as 25% of their population is student (Groningen, n.d). Harms et al (2014) showed in their research article that younger people are more likely to take a bike compared to older people, especially in cities.

The surrounding areas around the cities called the Ommelanden are rural and have one of the lowest population densities in the Netherlands compared to some other provinces with large urban locations (CBS, 2022). This also has an impact on the modal share of bicycles due to that destinations are located further away compared to urban areas, which leads to longer travel times (Harms et al., 2014). Another characteristic is that most of the rural municipalities have a lower amount of bicycle lanes in kilometres even though they are often larger than the municipality of the city of Groningen. Not only does this reduce the modal share of bicycles in rural municipalities but also the perceived safety as the presence of good bicycle lanes is an important factor to feel safe (Branion-Calles et al., 2019).

Ethics during research

Attention is paid to ethical values during the research process as it collects location data, which is considered sensitive according to the GDPR from the European Measures. Extra measures were implemented to ensure the anonymity of private data. For example, only the first four numbers of their postal code were asked to make a distinction between urban and rural areas. This data was aggregated in order to ensure the privacy of the respondents for the final product. Also, people were informed before that the research is completely voluntary and that they can stop at any time if they feel uncomfortable. People had to check a box if they have read this information. This research is accepted by the ethical committee of the Rijksuniversiteit Groningen with the current anonymity measures.

3.2 analysis

Cleaning up the questionnaire data file

Before the analysis, the data had to be cleaned up, as Maptionnaire collects a lot of data that are important to the functioning of the survey. But this data is not relevant for the analysis so these columns of the Excel file were deleted together with the numerous empty Excel columns that were scattered across the survey data. Another problem was that not all of the variables had a name in the Excel file so these were included with the help from the questionnaire.

Preparation of the data

The data had first to be prepared before both the spatial and statistical analyses, as a lot of information was still in text format and was not assigned a number. Thus all questions with a Likert scale were assigned a number with zero for completely agree till 4 for completely disagree and a 5 for the answer not applicable. Similarly, the location data were still the four numbers of the zip code, these also had to be changed to numbers. This was done by assigning all the zip codes in the city number one, as there are a lot less zip codes in the city compared to the rural areas. All the other zip codes, which were the rural areas were given the code of 0. This was done for the spatial analysis using the ESRI ArcGIS pro software and SPSS for the statistical analysis.

Spatial analysis

For the spatial analysis, the first thing was to join the shapefile with the Excell file, as Maptionnaire divides the map and general questions of the survey into two different documents. The join was done based on the unique respondent ID that Maptionnaire gives to each respondent. This join was done in order to differentiate between people from urban and rural areas in what kind of unsafe location they chose as most unsafe. For the spatial analysis, the presence of intersections, traffic lights, and bicycle lanes was used to analyse what kind of built environment the most chosen areas are and if it differs between people from urban and rural areas. These datasets for the built environment were downloaded from open street maps. From these open street maps data sets, the select by attribute function was used in order to create a layer for only traffic lights. Similarly, `for the bicycle lanes, the road-type cycle lane and the residential were chosen, as according to the Dutch guidelines both are meant to be safe for cyclists (Wijlhuizen et al., 2016). This meant however that some of the painted bicycle lanes on the primary, secondary, or tertiary are not included, as they do not have a specific classification for the presence of painted bicycle lanes. For the presence of intersections, the intersect analysis was performed with the use of the open street map road network in order to create point functions at the intersections. This selection was followed by creating buffers around the bicycle lanes, intersections, and traffic lights. For the bicycle lanes, a buffer of 10 meters was created around the polyline, for both the intersections and the traffic light the buffer was set to 25 meters in order to cover the whole intersection. Both the intersection and traffic lights buffers had quite some overlap especially at larger intersections, so the function dissolve borders was used in order to create one polygon for traffic lights, and one for intersections.

These datasets were used for the spatial analysis in order to find out what kind of built environment context people from both urban and rural areas picked as unsafe. For the urban area, this led to several different layers

1. An analysis of all the points in the city in order to find out what are the most unsafe places according to people from the city of Groningen. This was done with the density-based clustering function, using the Defined Distance (DBSCAN) clustering method. With the setting that at least 4 points are within 30 meters of each other.
2. The second layer is the points at intersections with traffic lights. This layer was created using the clip method between the traffic light buffer and the point data from the survey.
3. The third layer is about the intersections with bicycle lanes and is also created using the clip function in ArcGIS for both the intersection, and bicycle lane data.
4. The intersections without bicycle lanes is the fourth layer, and this is also created using the clip function. However, the erase function was used to erase the points that are also present at locations with a bicycle lane.
5. The last two layers are the road section one with bicycle lanes and the other without it. These layers were also created using both the erase and clip functions.

For the rural areas, the same layers were created with the exception of the traffic light layers. The reason for this exclusion is that there were only a limited amount of intersections with traffic lights and all of them were not really perceived as unsafe by the people from rural areas. These different layers and density clustering was used to analyse the most chosen locations in both rural and urban areas and what kind of built environment they are. Additionally, a distribution in percentages for each built environment type was created.

Statistical analysis

The intention was first to analyse the different Likert scale statements using the ordinal regression analysis. Unfortunately, almost all these for the different statements failed the parallel lines assumptions. This led to that binary logistic regression being used in this research to analyse the relationships between the socio-demographic factors with the perceived safety and perceived accessibility statements as the dependent variable. This means however that valuable information will be lost as the completely agree and agree answers needed to be grouped into one category and the same was done for completely disagree and disagree. This also led to that the category neither agree nor disagree will be excluded from this research. As a consequence this test does not look at the direction of the correlation but at how the independent variables impact the likelihood of success which is in this case the category agree. Using this statistical analysis led to the following null hypothesis: “In the population, all regression coefficients between the independent socio-demographic factors and the dependent variable are equal to zero” and alternative hypothesis: “In the population, the regression coefficients between the independent socio-demographic factors and the dependent variable is not equal to zero”. To determine the significance of the statistical test the usual p-value of 0,05 is used.

Binary logistic regression requires all categorical variables, which in this case are all socio-demographic factors to have a reference category to compare against. The reference categories can be seen in the table below.

Question	Reference category
What is your gender?	Male
What is your age?	65+
Location based on their zip code	Rural
How often do you cycle?	Daily (5 times a week or more)
For what kind of function do you use your bike the most?	Recreation
What kind of bike do you use the most?	A normal bike
What kind of destinations do you visit most often with your bike?	Locations in an urban area

Table 1: The reference values of the socio-demographic variables

For the variables about their age, how often they cycle, and what kind of function they use their bike for the most, the reference category is based on the theoretical framework. The reason why the age category 65+ was chosen is that according to Braver and Temple (2004), elderly people often have a slower reaction time, and are less agile compared to the other age groups, which can lead to a lower perceived safety rating. However, research about the impact of age is still inconclusive as there are several studies that show a relation while others do not (Guo et al., 2023). Therefore, this research aims to find out if elderly people respond differently compared to the other age groups to these statements in the province of Groningen. For the variable about how often they bike, the category daily was chosen for the reference category, because research has shown that people that cycle more often will also feel more safe due to experience (Ma and Dill, 2017). The reason why the category chosen was chosen compared to the never category is that the lowest category had less than 20 answers which is relatively low in a large data set and this can impact the statistical test. Recreation was chosen as a reference category, because they cycle for pleasure, and the other categories are about transporting to a destination.

The last analysis method is a word count analysis as people could fill in an optional question in the survey if they want to explain their choices as can be seen in Appendix 1. With these answers, a word cloud was generated, in this word cloud the not important words were left out such as the words: the and I. Of the most used important words a table was made and the words were further analysed to see if they are mostly used in a positive or negative context.

4. Results

Sample characteristics

The data collection together with RTV Noord led to 3086 respondents to the survey. Of the 3086 respondents, 51% of the sample is male and 49% is female as can be seen in Figure 2. This is representative of the population because according to CBS there are around 101 males for 100 females in the Province of Groningen (2022). Also, the ratio for respondents from rural and urban areas is almost similar as can be seen in Figure 3 with 53% of the sample from urban areas and 47% from rural areas. There is however quite a difference in age groups of the respondents as can be seen in Figure 4. Most of the respondents are in the age group 45-64 while there are a lot fewer in the categories 0-17 and 18-25. A reason for this is the data collection method as according to RTV Noord people between the ages of 45-64 and 65+ most use the website of RTV Noord.

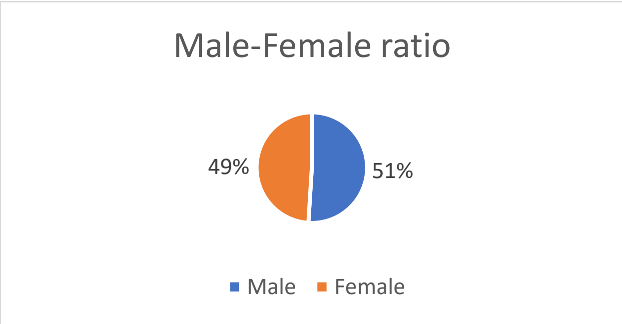

Figure 2: Male-Female ratio

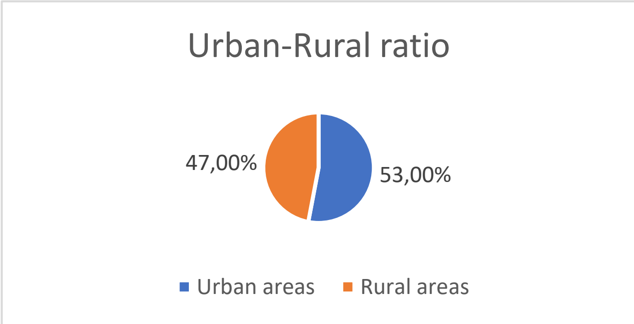

Figure 3: Urban-Rural ratio

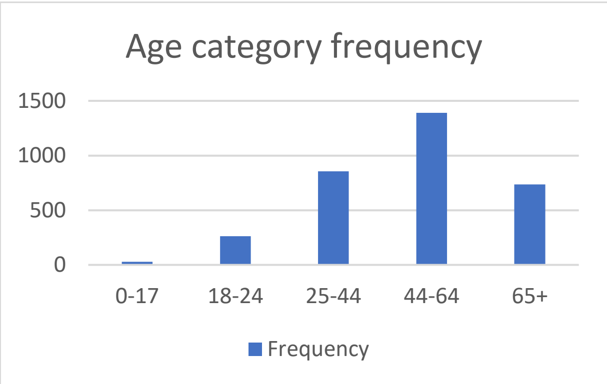

Figure 4: Age category frequency

4.1 Results of the spatial analysis

Clusters at locations with intersections in the urban context.

Ranking	Cluster	Point density	Built environment characteristics	
1	Intersection Westersingel and A straat	70	An intersection without bicycle lanes	

2	Intersection Helperzoom and Helperweg	60	An intersection with a two-lane bicycle path and a traffic island for cyclists	
3	Intersection Hoendiep and Aweg	42	Roundabout with separated bicycle lanes	
4	Intersection Bornholmstraat and Stockholmstraat	34	Intersection with a separated two-lane bicycle path. However, there are no facilities for cyclists crossing the street	
5	Roundabout Korreweg and J.C Kapteynlaan	26	A roundabout with bicycle lanes on the inside	
6	Roundabout Wilhelminakade and Princessenweg	24	A cycling roundabout with separated bicycle lanes and an intersection island for cyclists	
7	The intersection between Korreweg and Boterdiep	22	Intersection with one-lane bicycle paths and an intersection island for cyclist	
8	Intersection Korreweg and Nieuwe Ebbingestraat	20	Intersection with and one-way bicycle lane on each side of the road	
9	Intersection Eikenlaan and Wilgenpad	18	Intersection with bicycle lanes and an intersection island for cyclists	
9	Intersection Laan corpus den hoorn near the van Ketwich brug	18	Intersection with an one lane bicycle paths on each side of the road	
10	Intersection Herestraat and gedempte zuiderdiep	17	Intersection with a one-way bicycle lane on each side of the road	
10	Intersection Steentilbrug with schuitendiep	17	Intersection with a painted one-way bicycle lane on each side of the road	

Table 2: top ten most chosen locations by people living in the city of Groningen

As can be seen in Table 2, most of the top 10 selected locations are at intersections with bicycle lanes, especially one-way bicycle paths on each side of the road. A reason for this is the dense network of both bicycle lanes and roads in the city of Groningen. Of these intersections, three intersections are roundabouts while the others are threeway or four-way intersections. What is interesting is that a lot of the intersections with traffic lights are just outside of the top ten. Most of the intersections with traffic lights that are chosen a lot are the ones where all lights for cyclists go green. There is however one exception of one of these all green for cyclists intersections, which is the one where the Emmaviaduct crosses the Stationsweg, this intersection is hardly chosen by people with only one person choosing it, while most of the others have at least clusters of 5 people choosing it.

Due to the high network density in the city of Groningen, there are not a lot of clusters in the city of Groningen that are located in areas that do not have an intersection or bicycle path. Of the few clusters that are present, the largest one is the Verlengde Lodewijksweg near the station Europapark. There are also two smaller ones, the smallest one is the Westersingel and the other cluster is Nieuwe ebbingestaat. Both of these have intersections but there are a few points that people have picked that are outside the buffer of 15 meters from the intersection. It must however be noted that all of these clusters are relatively small compared to the clusters at intersections with the largest one the Verlengde Lodewijksweg having 11 points.

Even though in the urban context of the city of Groningen there is a large number of bicycle lanes or residential streets, there are not a lot of clusters at roads without intersections but that do have bicycle lanes as can be seen in Table 3 as only 10,5 % of the points are located in such built environment type. As a result, there is only one cluster, which is the Folkingerstraat. This street is designated as a shared space for cyclists and pedestrians. Which increases the contact between cyclists and pedestrians in the area (RTV Noord, 2018).

Built environment type	Percentage
Roads without bicycle lanes and intersections	25%
Roads with bicycle lanes but without intersections	10,5%
Intersections with bicycle lanes	51,3 %
Intersections without bicycle lanes	7,2%
Intersections with traffic lights	6%
Total	**100%**

Table 3: distribution in percentage for each built environment type by people from an urban context

Largest clusters and their built environment by people from a rural context

What is notable about the map responses from rural people is the large amount of locations in the city of Groningen they chose as unsafe. This has led to some clusters, as similar spaces compared to the responses from people in an urban context. Such as the crossing between the Helperzoom and Helperweg, the intersection between the Hoendiep and Aweg, the intersection between the A straat and Westersingel, and lastly the Nieuwe Ebbingweg/Korreweg intersection. All these locations are in the top 10 of the most chosen places by people living in the city as well.

However, the most chosen spots that are picked by people that live in a rural context are in the villages in the province. The most chosen spot is the Oldambtplein, which is a roundabout in the place of Winschoten (see Table 4). This cluster in Winshoten with a point density of 36 is significantly larger than the other clusters, which are often around 6 points. The reason for this is that a lot of people that live in the rural areas of the Province of Groningen, mostly identified road sections, some of which are several kilometres. As can be seen in Table 5 most of these road sections do not have any bicycle lanes with a percentage of 56,8. A few examples of such roads that are chosen the most are the Hoendiep between Hoogkerk and de Poffert (23 points), the road Pasop (10 points), Fanerweg (13 points), and the Mensumaweg (13 points) As can be seen in figure 4.

Ranking	Cluster	Point density	Built environment characteristics
1	Oldambtplein	36	A shared space Roundabout
2	Hoendiep between Hoogkerk and de Poffert	23	Provincial road with some bicycle lanes at intersections however most of the time cyclists have to share the same road
3	Mensumaweg	13	Road without bicycle lanes
3	Fanerweg	13	Provincial road without bicycle lanes
4	Pasop	10	Provincial road without bicycle lanes

Table 4: Most unsafe places in the rural area

Built environment type	Percentage
Roads without intersections and bicycle lanes	56,8%
Roads with bicycle lanes but without intersections	8,3%
Intersections with bicycle lanes	25,4
Intersections without bicycle lanes	9,5%
Total	**100%**

Table 5: distribution in percentage for each built environment type by people from a rural context

4.2 Results statistical analysis

The complete outcome tables of the statistical analysis can be seen in Appendix 2 to 15. In the results section only the summary is provided for the several binary logistic regression that were done. This summary exists out of the significance level of the model, the approximate R square, the variables that are significant with their significance and ultimately also their likelihood ratio.

The first binary logistic analysis that was done to see if the socio-demographic factors have an impact on the dependent variable as can be seen in Table 6 is for the statement: "the lanes for cyclists and cars are sufficiently separated". The summarized outcome of this analysis can be seen in Table 6.

Model for statement the lanes for cyclists and cars are sufficiently separated			
	Significance score	Nagelkerke R square	Percentage correctly classified
Complete model	0,294	X	

Table 6: summary of the outcome of the analysis between the socio-demographic characteristics and the statement about sufficient separation.

As can be seen in Table 6 the model that was produced during the analysis is not significant with a significance of 0,294 which is higher than the acceptable significance threshold of 0,05. This means that the H0 which in this case is: "In the population, all regression coefficients between the independent socio-demographic factors and the dependent variable sufficient separation is equal to zero" must be accepted.

The second regression model was done for the statement: "The design of the intersection sufficiently accommodates cyclists". As can be seen in Table 7 this model is significant with a significance level of 0,001. This means that the alternative hypothesis of the test: in the population, there is a relationship between the independent socio-demographic variables and the dependent intersection variable, must be accepted. The Nagelkerke R square of this model is 0,048 which means that 4,8% of the variance is explained by this model and it correctly classified 78,5% of the cases. As can be seen in Table 7 Females are 0,739 times less likely to agree with the statement that the design of the intersection sufficiently accommodates cyclists compared to males with a significance level of 0,047. Also, the variables people between the ages 25-44 and 45-64 are significant with a significance level of 0,036 and 0,040. This results into that given all other factors the variables people between the ages 25-44 and 45-64 are associated with lowering the likelihood to agree with the statement that the design of the intersection sufficiently accommodates cyclists compared to people above the age of 65.

Model for statement The design of the intersection sufficiently accommodates cyclists			
	Significance score	Nagelkerke R square	Percentage correctly classified
	0,001	0,048	78,5%
Variables in the equation which are significant			
Variable categories	Significance score	B	Exp(B)
Age 18-24	0,036	- 0,708	0,493
Age 25-44	0,040	- 0,525	0,591
Gender Female	0,047	- 0,302	0,739

Table 7: Summary of the analysis between the socio-demographic characteristics and the statement about sufficient accommodation of cyclists at intersections.

The third regression model between the socio-demographic variables and the statement: “It is clear where the cyclist should ride on the road” is significant with a significance level of 0,024 this means that the alternative hypothesis can be accepted. The Nagelkerke R square is 0,032 and it correctly classified 62,5% of the cases correctly. The table below shows that the variable E-bike is significant with a level of 0,022. This means when looking at Exp(B) that people that use an e-bike are 1,379 more likely to agree with the statement. The amount that people cycle is significant especially the people that sometimes or never cycle are 2,259 more likely to agree with the statement compared to people that cycle daily with a significance level of 0,021.

Model for statement It is clear where the cyclist should ride on the road			
	Significance score	Nagelkerke R square	Percentage correctly classified
	0,024	0,032	62,5%
Variables in the equation that are significant			
Variable category	Significance score	B	Exp(B)
E-bike	0,022	0,321	1,379
Amount: Sometimes and never	0,021	0,815	2,259

Table 8: Summary of the analysis between the socio-demographic characteristics and the statement about if it is clear where the cyclist must cycle.

The fourth statement for which a regression model was done is the statement: “There are sufficient designated bicycle lanes at this location”. This model proves to be significant with a significance level of 0,029. The model explains 3,4% of the variance with a Nagelkerke R square of 0,034, and it classified 56,5% of the cases correctly. For this model, only the bike type variable is significant as can be seen in Table 9 with a significance score of 0,002. With an Exp(B) of 1,568 people with E-bikes are 1,568 more likely to agree with the statement compared to people who use normal bikes given all other factors included in the model.

Model for statement There are sufficient designated bicycle lanes at this location			
	Significance score	Nagelkerke R square	Percentage correctly classified
	0,029	0,034	56,5%
Variables in the equation that are significant			
Variable	Significance score	B	Exp(B)
E-bikes	0,002	0,450	1,568

Table 9: Summary of the analysis between the socio-demographic characteristics and the statement about sufficient designated bicycle lanes.

Regression models for traffic intensity

The model for the statement: “I feel safer when cycling in a large group” is significant with a significance level of less than 0,001. According to the model, 6,8% of the variance is explained with a NagelKerke R square of 0,068 and it explained 76,1 % of the cases correctly. This model shows that the all different age groups are significant as can be seen in Table 10. With a Exp(B) of 4,700 people between the ages of 18 and 24 are 4,700 more likely to choose that they agree to the statement compared to 65+. Also, the group 25-44 and 45-64 have a larger chance to agree to the statement compared to elderly people with an exp(B) of 2,664 and 1,918. The variable utility trips is also significant as can be seen in the table below and the chance of agreeing to the statement is 1,804 times higher compared to people who chose that they use the bike for recreational trips the most.

Model for the statement I feel safer when cycling in a large group			
	Significance score	Nagelkerke R square	Percentage correctly classified
	< 0,01	0,068	75,8%
Variables in the equation that are significant			
Variable categories	Significance score	B	Exp(B)
18-24	<0,01	1,548	4,700
25-44	0,02	0,980	2,664
45-65	0,039	0,651	1,918
Utility	0,048	0,590	1,804

Table 10: Summary of the analysis between the socio-demographic characteristics and the statement about feeling safer when cycling in larger groups.

The statement: "There are too many cars on the road" is also analyzed by a model that is not significant with a score of 0,067 (see Table 11) so the null hypothesis: In the population, all regression coefficients between the independent socio-demographic factors and the dependent variable there are too many cars on the road is equal to zero" must be accepted in the case for this variable.

Model for statement There are too many cars on the road			
	Significance score	Nagelkerke R square	Percentage correctly classified
	0,067	X	

Table 11: Summary of the analysis between the socio-demographic characteristics and the statement about that there are too many cars

Binary regression models mode statements

As can be seen in the table below, the regression model for the statement: "When I cycle, I see cars as dangerous" is significant with a score of less than 0,001. According to the model, it explains 8% of the variance due to the Nagelkerke R square of 0,08. The model assigned 86,3% of all the cases the correct classification as seen in Table 12. In this model between the socio-demographic variables and the statement, the location variable is significant with a level of 0,023. With rural areas as a reference, people from the city have a lower likelihood to agree with this statement given all other factors compared to people from rural areas. This is similar to the other variable that is significant as can be seen in Table 12. This model shows that people that have the most destinations in a rural areas are 2,235 times more likely to choose to agree during the survey.

Model for statement When I cycle, I see cars as dangerous			
	Significance score	Nagelkerke R square	Percentage correctly classified
	< 0,01	0,08	86,3%
Variables in the equation that are significant			
Variable	Significance score	B	Exp(B)
Living in an urban location	0,023	-0,558	0,572
Most destinations are in a rural areas	0,005	0,930	2,535

Table 12: Summary of the analysis between the socio-demographic characteristics and the statement about that cars are seen as dangerous.

The second statement of the mode statements category is: "When I cycle, I see scooters as dangerous". According to the binary regression model that was done, this model has a significance level of less than 0,001, this leads to that the alternative hypothesis can be accepted which means that there is a relationship between the independent and the dependent variable. As can be seen in the table below the Nagelkerke R square is 0,083 and it classified 76,6% of the cases correctly. What is notable is that all the age groups are significant with 65+ as the reference group, as the significance level in the table shows. With a negative B, this means that the age groups 0-17, 18-24, 25-44 and 44-64 have a lower likelihood to choose one of the agree choices on the Likert scale at the survey compared to people above 65 given all the other factors included in the model. The other variable that is significant (Sig. 0,020) is the bike question. The category normal bike was chosen as reference category which means that people using an e-bike are less likely to agree to the statement that scooters are dangerous compared to people using a normal bike. Also, people from urban regions are associated with agreeing to this statement compared to people from rural areas with a significance of 0,030 and an Exp(B) of 1,543

Model for statement When I cycle, I see scooters as dangerous			
	Significance score	Nagelkerke R square	Percentage correctly classified
	< 0,01	0,085	76,3%
Variables in the equation			
Variable	Significance score	B	Exp(B)
Age 0-17	0,013	- 1,600	0,202
Age 18-24	< 0,01	- 1,364	0,256
Age 25-44	< 0,01	- 1,188	0,305
Age 45-64	0,022	- 0,707	0,493
Living in an urban location	0,32	0,428	1,534
E-bikes	0,022	0,22	0,667

Table 13: Summary of the analysis between the socio-demographic characteristics and the statement about that scooters are seen as dangerous.

According to the binary regression model the statement: "When I cycle, I see pedestrians as dangerous" with the socio-demographic variables is significant (sig. <0,001) and with a Nagelkerke R square of 0,099. The model predicted of all the cases included 62,3% correctly according to the classification table. Within this model, both female and people who use the gender other is significant as can be seen in Table 14. Both these variables are according to the model are associated with a higher chance of picking one of the two agree options compared to males. Also, all of the age groups with 65+ as the reference category proved to be significant as can be seen in the table below and with negative B scores the chance that they agree with the statement given all other factors included in the model is lower compared to people in the age group 65+. Another factor that is significant with a score of 0,001 is the category people living in cities. These urban people are according to the model are associated with agreeing more to this statement compared to rural people. Besides these factors also the factor trip purpose is significant (see table below) with utility and commuting trips increasing the chance of answering agree compared to the recreational trip makers. At last, similar to the location category as the location function people that most of their destinations in rural areas are less likely to agree as can be seen in the outcomes of the table.

Model for statement When I cycle, I see pedestrians as dangerous			
	Significance score	Nagelkerke R square	Percentage correctly classified
	< 0,001	0,099	55%
Variables in the equation that are significant			
Variable categories	Significance score	B	Exp(B)
Gender: Female	0,013	0,305	1,419
Gender: Other	0,026	2,645	11,765
Age group 0-17	0,23	-1,539	0,215
Age group 18-24	< 0,001	- 1,341	0,262
Age group 25-44	0,002	- 0,812	0,444
Age group 45-64	0,006	- 0,686	0,504
Living in an urban location	0,001	0,561	1,752
Utility trips	0,012	- 0,643	0,526
Commuting trips	0,040	- 0,537	0,585
Most destinations are in a rural area	0,006	- 0, 579	0,561

Table 14: Summary of the analysis between the socio-demographic characteristics and the statement about that pedestrians are seen as dangerous.

The model for the statement: "When I cycle, I see other cyclists as dangerous" is not significant according to the binary regression model with a score of 0,170 as can be seen in Table 15. This means that the H0 of the statistical test: In the population, the regression coefficients are zero between the independent socio-demographic variables and the dependent variable seeing cyclists as dangerous must be accepted and the alternative hypothesis needs to be rejected.

Model for statement When I cycle, I see other cyclists as dangerous			
	Significance score	Nagelkerke R square	Percentage correctly classified
	0,170	X	

Table 15: Summary of the analysis between the socio-demographic characteristics and the statement about that other cyclists are seen as dangerous.

For the last statement of the category traffic modes, I feel unsafe due to other road users, the binary regression model is significant as can be seen in the table below thus the alternative hypothesis that there is a relationship between the independent and dependent variable can be accepted. The model explains 10,6% of the variance with a Nagelkerke R square of 0,106 and it classified 83,9% of the cases correctly. The variable that shows a relationship given all factors included in the model is the variable gender, as the category female has a significance score of less than 0,001 and with an exp(B) of 1,894 and a positive B as can be seen in Table 16. It shows that females are 1,894 more likely to agree with the statement compared to males. Besides gender also the several age groups are relevant in this case the groups 18-24 and 25-44 as can be seen at the significance score in Table 16. Due to a negative B in the model, the age groups 18-24 and 25-44 are associated with lowering the likelihood of choosing agree or completely agree compared to the reference category of people above the age 65+. Additionally, also the variable location shows a relation with the dependent variable with a significance score of 0,026. In this case, a negative B means that urban people are less likely compared to rural people to choose the category agree.

Model for the statement I feel unsafe due to other road users			
	Significance score	Nagelkerke R square	Percentage correctly classified
	< 0,01	0,106	83,9%
Variables in the equation that are significant			
Variable categories	Significance score	B	Exp(B)
Gender: Female	< 0,01	0,639	1,894
Age group 18-24	<0,01	- 1,812	0,163
Age group 25-44	0,24	- 0,912	0,402
Living in an urban location	0,26	- 0,547	0,579

Table 16: Summary of the analysis between the socio-demographic characteristics and the statement about that other modes lead to a reduction in perceived safety.

Binary regression models for the perceived accessibility

The first statement of the category perceived accessibility is the statement: “If possible I avoid this place and prefer to use an alternate route”. The model for this statement with the socio-demographic characteristics as independent variables is significant with a score of less than 0,001. According to this binary regression model, it explained 7.6% of the variance with a Nagelkerke R square of 0,076 and as can be seen in Table 17 it assigned 65,8% of the cases the correct classification. In this model, the variable Gender is significant given all the other factors included in the model with a score of less than 0,001. And the results show that females are 1.674 more likely compared to males to choose an alternative route when cycling due to the perceived unsafety at specific places. Another variable that is significant given all the other factors included is the variable about which kind of bike they have as can be seen in the table that people with e-bikes are also more likely to choose another route when they cycle compared to people using a normal non-electric bike.

Model for statement If possible I avoid this place and prefer to use an alternate route			
	Significance score	Nagelkerke R square	Percentage correctly classified
	< 0,01	0,076	64,7%
Variables in the equation that are significant			
Variable categories	Significance score	B	Exp(B)
Gender: Female	< 0,01	0,515	1,674
E-bike	0,046	0,316	1,372

Table 17: Summary of the analysis between the socio-demographic characteristics and the statement about that that they choose another route when cycling.

The second variable of the category is: "I choose another transport mode, when I have to pass this location", its significant score is less than 0,001 which means that the model can be seen as statistically significant. This model explains relatively more of the variance compared to the other models with a Nagelkerke R square of 0,206, it also correctly classified 73,6% of the cases according to the classification table. The first category that is significant is females with a score of 0,032 and with a regression coefficient of 1,345, the category female is positively associated with agreeing to the statement. Another category that is significant (Sig. <0,01) is the urban location. With a negative regression coefficient as can be seen in Table 18, the results are that people from an urban region are less likely to agree with the statement compared to people from rural areas. The variable amount of times cycled in a week has the most categories significant. With the category a few times a week, and the category sometimes/never as significant with both scores of less than 0,001. And with both regression coefficients positive, the result is that people who cycle less often are more likely to take another mode of transport due to their perceived unsafety when cycling.

Model for the statement I choose another transport mode, when I have to pass this location			
	Significance score	Nagelkerke R square	Percentage correctly classified
	< 0,01	0,206	70,8%
Variables in the equation that are significant			
Variable categories	Significance score	B	Exp(B)
Living in an urban location	<0,01	- 1,704	0,342
Amount: A few times a week	<0,01	1,118	3,060
Amount: Sometimes and never	<0,01	1,558	4,751
Gender: Female	0,032	0,361	1,435

Table 18: Summary of the analysis between the socio-demographic characteristics and the statement about that that they choose another mode due to their perceived unsafety.

The last regression model is done for the statement: I have no alternative route or means of transportation to avoid this place “ which is also significant with a score of less than 0,001. It has however a lower Nagelkerke R square of 0,095 and only 65,5% of the cases were correctly classified by the model. The first variable that is significant as can be seen in the table below is gender with the category female having a 1,525 higher odds ratio to agree to this statement compared to males. Also, Age is significant with the age category 18-25 (sig. <0,001), which are less likely to agree with this statement compared to elderly people above 65 with a negative regression coefficient. Also, the amount people cycle has an impact together with the other factors included in the model. As the category often has a sig score of 0,003 and with a negative regression coefficient this means that it is associated with a reduction in agreeing to this statement compared to people that cycle every day. For this model also the trip functions of utility and commuting show an association with choosing agree for the statement.

Model for the statement I have no alternative route or means of transportation to avoid this place			
	Significance score	Nagelkerke R square	Percentage correctly classified
	< 0,01	0,095	62%
Variables in the equation that are significant			
Variable categories	Significance score	B	Exp(B)
Gender: Female	0,004	0,422	1,525
Age group 18-24	<0,01	- 1,128	0,324
Utility	0,035	0,553	1,739
Commuting	0,041	0,542	1,719
Amount: A few times a week	0,003	- 0,728	0,493

Table 19: Summary of the analysis between the socio-demographic characteristics and the statement about that that they do not have an alternative route or means of transportation.

4.3 Word count analysis

The questionnaire also included an optional question where people could explain their choice for their rating of the perceived safety in the province of Groningen. These answers are analysed with a word count analysis based on the distinction between urban and rural. The results of this analysis can be seen for people from rural areas in Table and for people from urban areas in Table 21.

Word	Amount of times mentioned
Car	104
High safety	35
Bad maintenance	31
Low amount of streetlights	17
Intersections	14

Table 20: Word count of people in rural areas

As can be seen in Table 20 the word car is most often mentioned by people from rural areas. The word is almost exclusively used in a negative context, especially the low amounts of separation between cars and cyclists are often mentioned, similarly the higher speed of cars is also mentioned relatively often together with the word car. What is interesting is that on the second spot of most mentioned words is the word high safety or similar words. However, this is often followed by an example where they do not feel as safe.

On the third spot are the words bad maintenance, a lot of people complain about the poor state of cycling infrastructure due to the large amounts, of cracks, holes and bumps in the bicycle lane. Bad maintenance is also often mentioned together with the low amount of streetlights near bicycle paths in rural areas. According to the respondents, the low amount of streetlights makes it fairly hard to see due to the darkness. At the last spot of the most mentioned words is the word intersection as a lot of people find these unclear or too busy.

Words	Amount of times mentioned
Car	116
Intersection	38
Narrow bicycle lane	27
Separated roads	25
Rule breaking	18

Table 21: Word count of people in urban areas.

As can be seen in Table 21 the most mentioned word is similar to people from rural areas as the word car which is mentioned 116 times. Also here is the speed of the cars mentioned relatively a lot, but people from urban areas mention the traffic intensity a lot more compared to the people that live in a rural area. In the second place is the word intersection, this word is quite often mentioned together with traffic lights. People often find that they have to wait too long for the bicycle traffic light to go green. What is most mentioned about intersections is the new intersections type, at this intersection, all the traffic lights for bicycles go green at the same time. This allows people to cross the intersection diagonally, instead of waiting for the traffic light to go green two times. However, according to the responses, a lot of people find these kinds of intersections chaotic and unclear. This chaoticness leads to that people are unsure how to act which can decrease the perceived safety according to the people that filled in the optional question. The word intersection is also often associated with the word on the shared fourth spot rule-breaking. A lot of people find that in the city, especially students do not follow the traffic rules, as they ride through red, and drive in the wrong direction on one-way streets is another example that is often mentioned. On the third spot is the word narrow bicycle lanes, as a lot of people are of the opinion that most of the bicycle lanes are too narrow, especially when they want to pass someone. At these narrow bicycle lanes also scooters are often an annoyance as they require a lot of space to pass someone.

The last word is separated bicycle lanes. This word is both used as a positive as quite a few people mention the high amount of separated bicycle lanes in the city of Groningen. However, most of the time it is used negatively, as a majority of people find that there is not enough separation between cars and bicycles. There are also a few that do not like the shared spaces between pedestrians and cyclists and want more separation between them but these are in the minority.

5. Discussion

The most notable result from the analyses is that according to the statistics not one of the category location urban/ rural show any relation with the perceived built environment statements. These perceived built environment statements are according to the statistical analysis mostly impacted by other factors such as age or the type of bike they use. Even though people from urban and rural people chose different built environments as their most unsafe locations according to the spatial analysis as can be seen in Tables 3 and 5. This shows that even though people from urban and rural areas were choosing different built environments as unsafe, there is no proof that they see the built environment as different. This proves the theory of Blitz (2021) that the perception of the built environment has to be looked at a local scale and that the regional scale of this research is too large to determine if urban and rural people perceive the built environment differently.

This can also be seen in the results of the spatial analysis where in the city of Groningen all of the top 10 of the most chosen places and more than 63,5% of the points are at intersections which confirms earlier research that intersections are often seen as unsafe due to a large number of interactions (Wexler and El-Geneidy, 2017; Dozza and Werneke, 2014; Gavriilidou et al., 2021). All of the locations in the top ten except one and 51,3% of the points are intersections with bicycle lanes. This is different from earlier research such as the one done by Branion-Calles et al. (2019) and Wexler and El-Geneidy (2017), which argue that the presence of bicycle lanes improves the perceived safety of that area. It must be said however that the absence of bicycle lanes at those locations could decrease the perceived safety even more. But it confirms the research done by Jamei et al. (2022) that only building bicycle lanes should not be the only measure for improving the perceived safety in an area. Even though Thomas and DeRobertis (2013) mention in their research that one-way bicycle lanes are perceived as safer compared to two-way bicycle lanes, most of the locations that are perceived as unsafe have a one-way bicycle lane on each side of the road. This can be explained by that one-way bicycle lanes are often quite narrow according to Von Stülpnagel and Binnig (2022) which can also be seen in the answers to the optional question that the narrowness of the bicycle lanes was more important than the cyclist intensity.

In the rural areas, most of the points are on roads without bicycle lanes with a percentage of 56,8%. Quite a few of the clusters in rural areas, such as the ones at the roads Pasop, Fanerweg, and the Mensuma weg are all 60 km/hour roads. These are considered quite small as there are no distinguished lanes for cars (Veilig verkeer Nederland, n.d.). This confirms the research done by Von Stülpnagel and Binnig (2022) that smaller roads lead to a lower perceived safety because according to them this is due to the closer interaction between cyclists and cars. In addition, people from rural areas also mention the lack of street lights at roads and bicycle lanes in the rural context which according to them decrease their perceived safety. This is due to the policy from the province of Groningen to only have streetlights outside the built-up area at intersections of bicycle lanes and provincial roads, otherwise they will other measures such as reflecting road markers (Province of Groningen, 2018). A similar result can also be seen in the research done by DiGioia et al. (2017). The lack of streetlights in rural areas is also quite often combined with poor maintenance of the road, the answers to the optional question affirm the claim made by King et al. (2020) that less-used roads in rural areas are often less maintained due to the low usage of it by cyclists.

Even though the percentage of points in a context without bicycle lanes differs considerably between rural and urban areas, according to the statistical analysis there is no relationship between the independent variables and the dependent variable about sufficient separation, as the model is insignificant. This is surprising as according to the literature separation is one of the most important factors for perceived safety (Branion-Calles et al., 2019; Chataway et al., 2014; Ohlund et al., 2021) as it decreases contact with motorized traffic modes such as cars (Lawson et al., 2013; Waitt et al., 2021). Similarly, the model about the traffic intensity of cars is also insignificant. Even though research has shown that also the traffic intensity, especially of cars also has a major impact on perceived safety as it increases the number of dangerous situations (Fitch et al. 2022). The reason for this difference between the outcome of this research and the academic literature is probably the statistical method that is used. The binary regression method only measures if the independent variables increase or disagree the chance of the category agree. The difference between completely agree and agree is left out, similarly for the category disagree. Also when using this method the category neither agree nor disagree is left out which can also have a difference. One other model is insignificant which is the model about seeing cyclists as dangerous. Even though current literature is conflicting about the impact of other cyclists, as it can both increase or decrease the perceived safety (Gavriilidou et al.,2021). This was also often mentioned in the optional question where according to the word count analysis it was mentioned 18 times by people in urban areas. In the optional question people in urban areas also mentioned often the intersections where all traffic lights for cyclists go green at the same time, according to them this creates a lot of chaos. This can also be seen in the spatial analysis as most of these intersections have several clusters as 6% of the points in urban areas are placed at such locations.

According to the spatial analysis, three of the top ten most chosen unsafe places in the urban area and the number one in the rural area are roundabouts. This means that there is no proof that people perceive roundabouts as safer compared to other intersections, also the roundabout of the Korreweg with the bicycle lanes inside the roundabout is not the most unsafe roundabout according to respondents of the city. This can be just these roundabouts in the province of Groningen, but it is different compared to the results of DiGioia et al. (2017) which say that in general segregated bicycle lanes are seen as safer. Also, the traffic lights are mentioned a lot in the optional question, especially the ones where all traffic lights for cyclists go green at the same time, however according to the spatial analysis the clusters at intersections with traffic lights are relatively small compared to some of the other clusters.

The category of urban/rural location has the most impact according to the regression models on the perception of different traffic modes. As can be seen in Table 12 people living in a rural context are more likely to see cars as dangerous compared to people from an urban context. According to Harms et al. (2014), the lack of bicycle lanes increases the modal interaction between cyclists and cars in rural areas. The answers to the optional question also reflect something similar as a lot of people from a rural context mention the car quite often together with their high speed outside the built-up area and the lack of separation, although similar things are also said quite often in the urban area. However, there is no proof that people from rural areas have the opinion that there are too many cars in the area as the model is insignificant. On the other hand, the result that the model about seeing pedestrians as unsafe when cycling is significant with one of the highest amounts of variance explained. This is different compared to the existing literature, which says that even though it can create some chaos, cyclists often see pedestrians as an annoyance due to the speed difference and not as a danger (Waitt et al., 2021). According to the model people living in urban areas are more likely to agree with this statement, this can also be seen in the word count analysis where several people wrote that there is not enough separation between cyclists and pedestrians in the inner city. The spatial analysis also shows something similar with a few clusters at shared spaces or locations where a lot of pedestrians-cyclists interactions happen such as the Grote Markt, Vismarkt, and the Folkingerstaat. However, all of these clusters fall outside the top 10 most chosen locations. This model also shows that gender has an impact, such as that females are more likely to see pedestrians as dangerous compared to males which confirms the theory that females are more likely to perceive a situation as unsafe when compared to males (Elvik and Bjørnskau, 2005; Olsson and Elldér, 2023). However, this is also the only model where the category gender: other is significant, unfortunately not a lot of research is done on how people who do not see themselves as male or female see the perceived safety and there is a chance that it can be impacted by the low amount of respondents that identify as such in the survey. Similarly, people from urban areas are also more likely to see scooters as unsafe compared to males. Tao et al. (2019) explained in their research that people cycling in urban contexts are more likely to come across different traffic modes. Another explanation is that according to the optional question, a lot of people have the opinion that the bicycle lanes are quite narrow, which leads to discomfort when a scooter wants to pass.

As can be seen in the results section gender has a large impact on the perception of cycling safety. However, for the five built environment statements the category gender is only significant once, which is the statement that junctions sufficiently accommodate cyclists. Females are less likely to agree with this statement compared to males which is similar to the outcome of the research done by Fitch et al. (2022) and Elvik and Bjørnskau (2005). However, according to Fitch et al. (2022), females also should feel less safe with the other built environment statements which is not the case in this research. A probable reason for this difference is as is said before the choice of statistical test. On the other hand, gender is significant for all the traffic modes statements that are significant. This proves that females are more likely to agree that they perceive different traffic modes as unsafe when cycling compared to males which is confirmed by Akgün-Tanbay et al. (2022).

Even though current literature is conflicting about the impact of age on perceived safety (Guo et al., 2023). This research shows that elderly people feel more unsafe compared to younger people, especially for the statements about seeing the different traffic modes as unsafe. This confirms the research done by Kaparias et al. (2012), Braver and Temple, (2004) about that elderly people feel unsafe when they come in contact with other traffic modes, according to them this is due to that elderly people have a slower reaction time compared to younger people. This can also be seen in Table 12, which shows that younger people are more likely to agree with the statement that they feel safe when cycling in large groups. This confirms the theory that people can feel safer due to safety in numbers (Aldred and Jungnickel,2014; Jacobsen, 2015). The fact that elderly people feel more unsafe when cycling is due to the fact that they need more space due to the slower reaction time (Kaparias et al. 2012; Braver and Temple, 2004), which is often not present in large groups which can lead to a feeling of unsafety (Gössling and McRae, 2022).

The trip purpose does not have a large impact as the only model where these categories are significant is the model about seeing pedestrians as unsafe. According to this model, people who use the bike for utility and commuting trips are less likely to see them as dangerous compared to people who cycle for recreation. This is however different compared to other research because Poulos et al. (2017) show in their research that people that cycle who cycle often for transport also will have more interactions and near misses with pedestrians which can decrease their perceived safety.

On the other hand, the usage of an E-bike does have an impact on how they perceive the built environment as according to the binary logistic regression people who use an e-bike are more likely to agree to the statements that there are sufficient marked bicycle lanes and that it is clear where people should bike. This is rather surprising because Table 17 shows that people using E-bikes are more likely to agree to use another route due to perceived safety and Haustein and Møller (2016) show that people using E-bikes often feel that their other people underestimate them which increases the near collisions using an bike, which decreases the perceived safety even further.

This research comes to the same result compared to Ma and Dill (2017) that the perceived safety has an impact on the perceived accessibility of cyclists, as there are several categories that are significant in the models for route and mode choice due to feeling unsafe. According to Ma and Dill (2017) people who cycle often also feel more safe due to having experience with unsafe situations. Surprisingly, the category sometimes and never shows a positive association with the statement that it is clear where they should ride, while Ma and Dill say in their research that people who cycle a lot should feel safer about the perceived built environment . However, there is evidence that people who cycle less are more likely to take another travel mode due to feeling unsafe when cycling, as seen in Table 18. Harms et al. (2014) argue in their research that people in rural areas are more likely to take the car compared to people from urban areas due to the lack of cycling infrastructure. This research confirms this theory and proves that even though in urban areas the modal choice is higher, rural people are still more likely to choose another mode. Gender also has an impact on the mode choice according to Olsson and Elldér (2023), as females are more likely compared to males to use a car or take another route, because of their perception of unsafety when cycling. This research shows a similar result as according to Tables 17 and 18 females are more likely to agree to the statement about that they will take another transport mode or another route because they feel unsafe when cycling. In addition, also people with E-bikes are more likely to choose another route because of their perceived unsafety compared to people using a normal bike, even though there is not a lot of research done on the travel behaviour of E-bike cyclists. However, Haustein and Møller (2016) show that people using e-bikes often drive at higher speeds, which also means that more space is needed to drive more safely according to Pucher and Buehler (2008) which can explain this result. Interestingly, females are also more likely to agree to the statement that they have no other route or mode choic**e** even though the other models also prove that females are more likely to take another route or mode.

6. Conclusion

The aim of this research is to answer the following research question: “What attributes of safety are perceived as most important In urban and rural areas by inhabitants province of Groningen?”. To answer this research question a questionnaire was carried out which was analysed using both spatial and statistical analysis.

To answer the first sub-question: “How do people from urban and rural areas perceive cycling safety differently? “ According to the statistical and spatial analysis, there is no indication that people from rural and urban contexts perceive their built environment differently, even though they chose completely different built environments for their most unsafe spot. This perception of the built environment was mainly influenced by the socio-demographic factors such as what kind of bike they use, gender, and age. In addition, the model for the car intensity was insignificant which means that there is no proof that people from urban and rural contexts perceive the traffic intensity differently. In contrast, the statistical analysis shows that the urban/rural distinction does have an impact on the perception of different traffic modes. This means that the first hypothesis can be rejected.

Three statements were used to answer sub-question two: “Does the difference in perceived safety between urban and rural people lead to a difference in perceived accessibility?”. The spatial analysis shows that the urban/rural context only has an impact on what kind of mode they use and not on route choice, as rural people are more likely to choose another transport mode, even though there is a larger mode choice in cities. This means that the second hypothesis can also be rejected.

The third sub-question is: “How do the socio-demographic characteristics of people impact the perceived safety and perceived accessibility in rural and urban regions?”. The statistical analysis shows that the categories of gender and age have a large impact on the perceived safety and perceived accessibility and to a lesser degree the type of bike they use. This can be seen in the fact that both elderly people and females are more likely to agree that they perceive the built environment and other traffic modes as unsafe compared to younger people and males. The fact that female feel more unsafe when cycling compared to males can also be seen in the perceived accessibility as females are more likely to take another traffic mode and another route. Age on the other hand does not show such an effect, which means that the third hypothesis can be partly confirmed.

The spatial analysis shows that a lot of people feel unsafe at intersections with bicycle lanes. To get a better understanding of perceived safety a more qualitative analysis of these intersections should be conducted in order to get a better understanding of perceived safety, as this proves that building bicycle lanes is not enough for people to feel safe. With a more qualitative research, better insights can be generated into why people feel unsafe there and this can lead to new measures for policymakers in order to make cycling safer. Besides that, this research could also be done with a stronger statistical method as currently a lot of valuable information was lost due to creating a binary system. This research however proves that there is a difference between people living in an urban and rural context in how they perceive cycling safety, especially seeing different traffic modes as dangerous. Policymakers can use these insights together with the location that people perceive as the most dangerous in order to implement measures in order to increase the perceived safety. The insight into how people from urban and rural contexts perceive their safety can be used by policymakers in order to have different approaches between rural and urban contexts in how to increase the perceived safety, especially for the difference in traffic modes they perceive as unsafe.

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8. Appendix

Questions	Possible answers	Variable type
Socio-demographic characteristics		
What is your gender?	0: Male 1: Female 2: Other	Nominal
What is your age?	0: 0-17 1: 18-24 2:25-44 3: 45-64 4: 65+	Ordinal
What are the first four digits of your zip code?	Open question	
How often do you cycle?	0: Daily (at least 5 times a week 1: Often (3-4 times a week 2: A few times a week (1-2 times a week) 3: Sometimes (less than 1 time a week) 4: Never	Ordinal
For what kind of function do you use your bike the most?	0: Recreation 1: Utility trips 2: Commuting 3: Other functions	Nominal
What kind of bike do you use the most?	0: A normal bike 1: An E-bike	Nominal
What kind of destinations do you visit most often with your bike?	0: Destinations in an urban area 1: Destinations in an rural area	Nominal

Statements	Possible answers	Variable types
Locate on the map of the province of Groningen a location you find unsafe to cycle upon	Map question	
Questions design of cycling infrastructure		
The lanes for cyclists and cars are sufficiently separated	0: Completely agree 1: Agree 2: Neither agree or disagree 3: Disagree 4: Completely disagree 5 Not applicable	Ordinal
The design of the intersection sufficiently accommodates cyclists	0: Completely agree 1: Agree 2: Neither agree or disagree 3: Disagree 4: Completely disagree 5 Not applicable	Ordinal
It is clear where the cyclist should ride on the road	0: Completely agree 1: Agree 2: Neither agree or disagree 3: Disagree 4: Completely disagree 5 Not applicable	Ordinal
There are sufficient designated bicycle lanes at this location	0: Completely agree 1: Agree 2: Neither agree or disagree 3: Disagree 4: Completely disagree 5 Not applicable	Ordinal
Questions traffic intensity		
I feel safer when cycling in a large group	0: Completely agree 1: Agree 2: Neither agree or disagree 3: Disagree 4: Completely disagree 5 Not applicable	Ordinal
There are too many cars on the road	0: Completely agree 1: Agree 2: Neither agree or disagree 3: Disagree 4: Completely disagree 5 Not applicable	Ordinal
Statements about other road users		
When I cycle, I see cars as dangerous	0: Completely agree 1: Agree 2: Neither agree or disagree 3: Disagree 4: Completely disagree 5 Not applicable	Ordinal

When I cycle, I see scooters as dangerous	0: Completely agree 1: Agree 2: Neither agree or disagree 3: Disagree 4: Completely disagree 5 Not applicable	Ordinal
When I cycle, I see pedestrians as dangerous	0: Completely agree 1: Agree 2: Neither agree or disagree 3: Disagree 4: Completely disagree 5 Not applicable	Ordinal
When I cycle, I see other cyclists as dangerous	0: Completely agree 1: Agree 2: Neither agree or disagree 3: Disagree 4: Completely disagree 5 Not applicable	Ordinal
I feel unsafe due to other road users	0: Completely agree 1: Agree 2: Neither agree or disagree 3: Disagree 4: Completely disagree 5 Not applicable	Ordinal
Statements about avoiding unsafe situations		
If possible I avoid this place and prefer to use an alternate route	0: Completely agree 1: Agree 2: Neither agree or disagree 3: Disagree 4: Completely disagree 5 Not applicable	Ordinal
I choose another transport mode, when I have to pass this location	0: Completely agree 1: Agree 2: Neither agree or disagree 3: Disagree 4: Completely disagree 5 Not applicable	Ordinal
I have no alternative route or means of transportation to avoid this place	0: Completely agree 1: Agree 2: Neither agree or disagree 3: Disagree 4: Completely disagree 5 Not applicable	Ordinal
Questions perceived safety		
Which factors are according to you the most important for a safe location when cycling? Choose max 2.	0: Sufficient separation between car lanes and bicycle lanes. 1: Sufficient lighting of bicycle lanes 2: An intersection design that takes into account cyclists	Nominal

	3: Well-maintained bicycle lanes 4: Low volumes of motorized traffic, such as cars or scooters 5: Wide bicycle lanes	
Point to an example on the map of a safe location for cycling in the province of Groningen.	Map question	
On a scale of 1 to 10, how would you rate the bicycle safety in the province of Groningen?	0: 1 (Completely unsafe) 1: 2 3: 4 4: 5 5: 6 6: 7 7: 8 8: 9 9: 10 (Completely safe	Ordinal
Would you like to explain why you gave this rating? This is optional.	Open question	
Question further research		
Would you like to participate in a news report by RTV Noord or in follow-up research? Please leave your contact information here. This contact information will only be used for this purpose and not for other purposes.	Open question	

Appendix 2: Regression model for the statement: the lanes for cyclists and cars are sufficiently separated.

Classification Table[a,b]

Observed			Predicted: Dummy_Seperation ,00	Predicted: Dummy_Seperation 1,00	Percentage Correct
Step 0	Dummy_Seperation	,00	636	0	100,0
		1,00	573	0	,0
	Overall Percentage				52,6

a. Constant is included in the model.

b. The cut value is ,500

Appendix 2a: Classification table

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	17,426	15	,294
	Block	17,426	15	,294
	Model	17,426	15	,294

Appendix 2b: Omnibus tests

Appendix 3: Regression model for the statement: The design of the intersection sufficiently accommodates cyclists.

Classification Table[a]

	Observed		Predicted: Dummy_junction ,00	Predicted: Dummy_junction 1,00	Percentage Correct
Step 1	Dummy_junction	,00	905	0	100,0
		1,00	248	0	,0
	Overall Percentage				78,5

a. The cut value is ,500

Appendix 3a: Classification table

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	36,544	15	,001
	Block	36,544	15	,001
	Model	36,544	15	,001

Appendix 3b: Omnibus tests

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1164,016[a]	,031	,048

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than ,001.

Appendix 3c: Nagelkerke R square

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Leeftijd			19,057	4	<,001	
	Leeftijd(1)	,639	,613	1,085	1	,297	1,894
	Leeftijd(2)	-,708	,338	4,387	1	,036	,493
	Leeftijd(3)	-,525	,256	4,207	1	,040	,591
	Leeftijd(4)	,106	,233	,208	1	,648	1,112
	Geslacht			3,949	2	,139	
	Geslacht(1)	-,302	,152	3,949	1	,047	,739
	Geslacht(2)	-,125	,682	,034	1	,855	,883
	Locatie(1)	,005	,183	,001	1	,977	1,005
	Waarvoor			,519	3	,915	
	Waarvoor(1)	-,090	,257	,122	1	,727	,914
	Waarvoor(2)	-,164	,268	,376	1	,540	,849
	Waarvoor(3)	-,248	,512	,235	1	,627	,780
	wat_voorfiets(1)	,214	,162	1,730	1	,188	1,238
	Bestemming(1)	-,425	,222	3,666	1	,056	,654
	Amount			6,092	3	,107	
	Amount(1)	-,229	,186	1,519	1	,218	,795
	Amount(2)	,223	,241	,858	1	,354	1,250
	Amount(3)	,551	,361	2,332	1	,127	1,735
	Constant	-,845	,369	5,254	1	,022	,429

a. Variable(s) entered on step 1: Leeftijd, Geslacht, Locatie, Waarvoor, wat_voorfiets, Bestemming, Amount.

Appendix 3d: Variables in the equation

Appendix 4 Regression model for the statement: It is clear where the cyclist should ride on the road.

Classification Table[a]

Observed			Predicted Dumy_clear ,00	Predicted Dumy_clear 1,00	Percentage Correct
Step 1	Dumy_clear	,00	23	420	5,2
		1,00	20	709	97,3
	Overall Percentage				62,5

a. The cut value is ,500

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	27,683	15	,024
	Block	27,683	15	,024
	Model	27,683	15	,024

Appendix 4a: Classification table

Appendix 4b: Omnibus tests

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1526,552[a]	,023	,032

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than ,001.

Appendix 4c: Nagelkerke R square

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Leeftijd			6,481	4	,166	
	Leeftijd(1)	-,861	,606	2,019	1	,155	,423
	Leeftijd(2)	,048	,270	,032	1	,858	1,049
	Leeftijd(3)	,313	,216	2,099	1	,147	1,367
	Leeftijd(4)	,140	,205	,469	1	,493	1,151
	Geslacht			5,008	2	,082	
	Geslacht(1)	-,185	,127	2,120	1	,145	,832
	Geslacht(2)	-1,095	,604	3,289	1	,070	,334
	Locatie(1)	,116	,157	,546	1	,460	1,123
	Waarvoor			4,633	3	,201	
	Waarvoor(1)	,104	,213	,240	1	,624	1,110
	Waarvoor(2)	,320	,220	2,122	1	,145	1,378
	Waarvoor(3)	-,316	,408	,599	1	,439	,729
	wat_voorfiets(1)	,321	,140	5,228	1	,022	1,379
	Bestemming(1)	,069	,182	,142	1	,706	1,071
	Amount			6,119	3	,106	
	Amount(1)	,048	,149	,103	1	,748	1,049
	Amount(2)	-,097	,207	,220	1	,639	,908
	Amount(3)	,815	,354	5,300	1	,021	2,259
	Constant	,022	,307	,005	1	,942	1,022

a. Variable(s) entered on step 1: Leeftijd, Geslacht, Locatie, Waarvoor, wat_voorfiets, Bestemming, Amount.

Appendix 4d: Variables in the equation

Appendix 5: Regression model for the statement: There are sufficient designated bicycle lanes at this location.

Classification Table[a]

Observed			Predicted Dummy_Marking ,00	Predicted Dummy_Marking 1,00	Percentage Correct
Step 1	Dummy_Marking	,00	163	332	32,9
		1,00	129	436	77,2
	Overall Percentage				56,5

a. The cut value is ,500

Appendix 5a: Classification table

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	26,944	15	,029
	Block	26,944	15	,029
	Model	26,944	15	,029

Appendix 5b: Omnibus tests

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1437,902[a]	,025	,034

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than ,001.

Appendix 5c: Nagelkerke R square

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Leeftijd			2,902	4	,574	
	Leeftijd(1)	-,494	,573	,743	1	,389	,610
	Leeftijd(2)	-,176	,276	,407	1	,523	,839
	Leeftijd(3)	,107	,223	,229	1	,632	1,113
	Leeftijd(4)	-,053	,211	,063	1	,802	,948
	Geslacht			2,963	2	,227	
	Geslacht(1)	,063	,128	,240	1	,624	1,065
	Geslacht(2)	-1,300	,809	2,583	1	,108	,273
	Locatie(1)	,217	,160	1,839	1	,175	1,242
	Waarvoor			1,326	3	,723	
	Waarvoor(1)	-,139	,222	,392	1	,531	,870
	Waarvoor(2)	,027	,227	,014	1	,905	1,027
	Waarvoor(3)	-,136	,445	,094	1	,760	,873
	wat_voorfiets(1)	,450	,144	9,737	1	,002	1,568
	Bestemming(1)	-,271	,184	2,174	1	,140	,763
	Amount			1,424	3	,700	
	Amount(1)	-,057	,154	,138	1	,710	,944
	Amount(2)	,122	,211	,334	1	,563	1,130
	Amount(3)	,304	,349	,761	1	,383	1,356
	Constant	-,058	,315	,034	1	,854	,944

a. Variable(s) entered on step 1: Leeftijd, Geslacht, Locatie, Waarvoor, wat_voorfiets, Bestemming, Amount.

Appendix 5d: Variables in the equation

Appendix 6: Regression model for the statement: I feel safer when cycling in a large group.

Classification Table[a]

Observed			Predicted Dummy_largergroups ,00	Predicted Dummy_largergroups 1,00	Percentage Correct
Step 1	Dummy_largergroups	,00	737	3	99,6
		1,00	230	6	2,5
	Overall Percentage				76,1

a. The cut value is ,500

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	45,334	15	<,001
	Block	45,334	15	<,001
	Model	45,334	15	<,001

Appendix 6a: Classification table

Appendix 6b: Omnibus tests

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1034,414[a]	,045	,068

a. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

Appendix 6c: Nagelkerke R square

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Leeftijd			22,371	4	<,001	
	Leeftijd(1)	1,016	,749	1,838	1	,175	2,761
	Leeftijd(2)	1,548	,363	18,144	1	<,001	4,700
	Leeftijd(3)	,980	,322	9,246	1	,002	2,664
	Leeftijd(4)	,651	,315	4,267	1	,039	1,918
	Geslacht			1,195	2	,550	
	Geslacht(1)	-,173	,158	1,195	1	,274	,841
	Geslacht(2)	-20,185	14941,484	,000	1	,999	,000
	Locatie(1)	,071	,202	,123	1	,725	1,074
	Waarvoor			5,778	3	,123	
	Waarvoor(1)	,590	,299	3,905	1	,048	1,804
	Waarvoor(2)	,253	,304	,694	1	,405	1,288
	Waarvoor(3)	,476	,503	,895	1	,344	1,610
	wat_voorfiets(1)	-,029	,180	,026	1	,872	,971
	Bestemming(1)	-,027	,236	,013	1	,910	,974
	Amount			,865	3	,834	
	Amount(1)	-,138	,193	,508	1	,476	,871
	Amount(2)	-,204	,272	,565	1	,452	,815
	Amount(3)	-,014	,407	,001	1	,972	,986
	Constant	-2,204	,453	23,723	1	<,001	,110

a. Variable(s) entered on step 1: Leeftijd, Geslacht, Locatie, Waarvoor, wat_voorfiets, Bestemming, Amount.

Appendix 6d: Variables in the equation

Appendix 7: Regression model for the statement: There are too many cars on the road.

Classification Table[a,b]

Observed			Predicted Dummy_toomanycars ,00	1,00	Percentage Correct
Step 0	Dummy_toomanycars	,00	0	168	,0
		1,00	0	801	100,0
	Overall Percentage				82,7

a. Constant is included in the model.

b. The cut value is ,500

Appendix 7a: Classification table

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	23,895	15	,067
	Block	23,895	15	,067
	Model	23,895	15	,067

Appendix 7b: Omnibus tests

Appendix 8: Regression model for the statement: When I cycle, I see cars as dangerous.

Classification Table[a]

Observed			Predicted Dummy_cardangerous ,00	Predicted Dummy_cardangerous 1,00	Percentage Correct
Step 1	Dummy_cardangerous	,00	0	151	,0
		1,00	0	951	100,0
	Overall Percentage				86,3

a. The cut value is ,500

Appendix 8a: Classification table

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	49,574	15	<,001
	Block	49,574	15	<,001
	Model	49,574	15	<,001

Appendix 8b: Omnibus tests

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	830,975[a]	,044	,080

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than ,001.

Appendix 8c: Nagelkerke R square

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Leeftijd			7,026	4	,135	
	Leeftijd(1)	-,488	,855	,326	1	,568	,614
	Leeftijd(2)	-,705	,398	3,141	1	,076	,494
	Leeftijd(3)	-,045	,364	,015	1	,902	,956
	Leeftijd(4)	-,183	,347	,278	1	,598	,833
	Geslacht			,881	2	,644	
	Geslacht(1)	,174	,187	,871	1	,351	1,190
	Geslacht(2)	-,037	1,107	,001	1	,973	,964
	Locatie(1)	-,558	,246	5,152	1	,023	,572
	Waarvoor			,910	3	,823	
	Waarvoor(1)	,084	,382	,049	1	,826	1,088
	Waarvoor(2)	-,028	,377	,005	1	,942	,973
	Waarvoor(3)	-,377	,575	,430	1	,512	,686
	wat_voorfiets(1)	-,086	,215	,160	1	,689	,918
	Bestemming(1)	,930	,335	7,713	1	,005	2,535
	Amount			,723	3	,868	
	Amount(1)	,135	,237	,325	1	,568	1,145
	Amount(2)	-,069	,331	,043	1	,835	,933
	Amount(3)	-,204	,459	,196	1	,658	,816
	Constant	2,163	,531	16,568	1	<,001	8,694

a. Variable(s) entered on step 1: Leeftijd, Geslacht, Locatie, Waarvoor, wat_voorfiets, Bestemming, Amount.

Appendix 8d: Variables in the equation

Appendix 9: Regression model for the statement: When I cycle, I see scooters as dangerous.

Classification Table[a]

			Predicted		
			Dummy_scooters_dangerous		Percentage Correct
	Observed		,00	1,00	
Step 1	Dummy_scooters_dangerous	,00	7	229	3,0
		1,00	5	756	99,3
	Overall Percentage				76,5

a. The cut value is ,500

Appendix 9a: Classification table

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	57,775	16	<,001
	Block	57,775	16	<,001
	Model	57,775	16	<,001

Appendix 9b: Omnibus tests

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1033,457[a]	,056	,085

a. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

Appendix 9c: Nagelkerke R square

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Geslacht			1,221	2	,543	
	Geslacht(1)	,167	,161	1,072	1	,300	1,181
	Geslacht(2)	,502	1,137	,195	1	,659	1,653
	Leeftijd			20,142	4	<,001	
	Leeftijd(1)	-1,600	,646	6,140	1	,013	,202
	Leeftijd(2)	-1,364	,371	13,544	1	<,001	,256
	Leeftijd(3)	-1,188	,321	13,726	1	<,001	,305
	Leeftijd(4)	-,707	,309	5,227	1	,022	,493
	Locatie(1)	,428	,200	4,590	1	,032	1,534
	Hoeveelheid			2,656	4	,617	
	Hoeveelheid(1)	-,006	,192	,001	1	,974	,994
	Hoeveelheid(2)	-,333	,260	1,645	1	,200	,717
	Hoeveelheid(3)	-,429	,394	1,184	1	,276	,651
	Hoeveelheid(4)	19,220	23182,645	,000	1	,999	222316847,11
	Waarvoor			4,383	3	,223	
	Waarvoor(1)	,023	,275	,007	1	,933	1,024
	Waarvoor(2)	-,362	,270	1,799	1	,180	,696
	Waarvoor(3)	-,114	,499	,053	1	,819	,892
	wat_voorfiets(1)	-,405	,176	5,270	1	,022	,667
	Bestemming(1)	-,315	,221	2,037	1	,154	,730
	Constant	2,252	,422	28,507	1	<,001	9,508

a. Variable(s) entered on step 1: Geslacht, Leeftijd, Locatie, Hoeveelheid, Waarvoor, wat_voorfiets, Bestemming.

Appendix 9d: Variables in the equation

Appendix 10: Regression model for the statement: When I cycle, I see pedestrians as dangerous.

Classification Table[a]

Observed			Predicted Dummy_pedestriansdangerous ,00	1,00	Percentage Correct
Step 1	Dummy_pedestriansdangerous	,00	198	227	46,6
		1,00	129	390	75,1
	Overall Percentage				62,3

a. The cut value is ,500

Appendix 10a: Classification table

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	72,367	15	<,001
	Block	72,367	15	<,001
	Model	72,367	15	<,001

Appendix 10b: Omnibus tests

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1226,919[a]	,074	,099

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than ,001.

Appendix 10c: Nagelkerke R square

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Geslacht			10,452	2	,005	
	Geslacht(1)	,350	,141	6,119	1	,013	1,419
	Geslacht(2)	2,465	1,107	4,959	1	,026	11,765
	Leeftijd			20,023	4	<,001	
	Leeftijd(1)	-1,539	,675	5,204	1	,023	,215
	Leeftijd(2)	-1,341	,311	18,533	1	<,001	,262
	Leeftijd(3)	-,812	,263	9,530	1	,002	,444
	Leeftijd(4)	-,686	,250	7,525	1	,006	,504
	Locatie(1)	,561	,175	10,268	1	,001	1,752
	Waarvoor			8,910	3	,031	
	Waarvoor(1)	-,643	,255	6,352	1	,012	,526
	Waarvoor(2)	-,537	,261	4,227	1	,040	,585
	Waarvoor(3)	,326	,494	,435	1	,510	1,385
	wat_voorfiets(1)	-,075	,160	,217	1	,641	,928
	Bestemming(1)	-,579	,212	7,445	1	,006	,561
	Amount			1,176	3	,759	
	Amount(1)	-,095	,168	,321	1	,571	,909
	Amount(2)	,134	,233	,329	1	,566	1,143
	Amount(3)	-,162	,352	,213	1	,645	,850
	Constant	1,130	,366	9,562	1	,002	3,096

a. Variable(s) entered on step 1: Geslacht, Leeftijd, Locatie, Waarvoor, wat_voorfiets, Bestemming, Amount.

Appendix 10d: Variables in the equation

Appendix 11: Regression model for the statement: When I cycle, I see other cyclists as dangerous.

Classification Table[a]

Observed			Predicted Dummy_bicycledangerous ,00	Predicted Dummy_bicycledangerous 1,00	Percentage Correct
Step 1	Dummy_bicycledangerous	,00	735	0	100,0
		1,00	227	1	,4
	Overall Percentage				76,4

a. The cut value is ,500

Appendix 11a: Classification table

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	20,047	15	,170
	Block	20,047	15	,170
	Model	20,047	15	,170

Appendix 11b: Omnibus tests

Appendix 12: Regression model for the statement: I feel unsafe due to other road users

Classification Table[a]

Observed			Predicted Dummy_otherusers ,00	1,00	Percentage Correct
Step 1	Dummy_otherusers	,00	2	157	1,3
		1,00	2	826	99,8
	Overall Percentage				83,9

a. The cut value is ,500

Appendix 12a: Classification table

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	63,571	15	<,001
	Block	63,571	15	<,001
	Model	63,571	15	<,001

Appendix 12b: Omnibus tests

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	807,911[a]	,062	,106

a. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

Appendix 12c: Nagelkerke R square

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Geslacht			11,379	2	,003	
	Geslacht(1)	,639	,189	11,379	1	<,001	1,894
	Geslacht(2)	19,223	14041,050	,000	1	,999	222985673,00
	Leeftijd			25,263	4	<,001	
	Leeftijd(1)	-,380	1,121	,115	1	,734	,684
	Leeftijd(2)	-1,812	,441	16,890	1	<,001	,163
	Leeftijd(3)	-,912	,403	5,128	1	,024	,402
	Leeftijd(4)	-,630	,393	2,575	1	,109	,532
	Locatie(1)	-,547	,245	4,981	1	,026	,579
	Waarvoor			1,623	3	,654	
	Waarvoor(1)	,224	,352	,405	1	,525	1,251
	Waarvoor(2)	,175	,345	,256	1	,613	1,191
	Waarvoor(3)	,857	,690	1,543	1	,214	2,357
	wat_voorfiets(1)	-,415	,215	3,723	1	,054	,660
	Bestemming(1)	,358	,303	1,394	1	,238	1,430
	Amount			4,397	3	,222	
	Amount(1)	-,244	,222	1,200	1	,273	,784
	Amount(2)	,198	,350	,319	1	,572	1,218
	Amount(3)	-,702	,430	2,660	1	,103	,496
	Constant	2,525	,547	21,293	1	<,001	12,494

a. Variable(s) entered on step 1: Geslacht, Leeftijd, Locatie, Waarvoor, wat_voorfiets, Bestemming, Amount.

Appendix 12d: Variables in the equation

Appendix 13: Regression model for the statement: If possible I avoid this place and prefer to use an alternate route.

Classification Table[a]

Observed			Predicted: Dummy_otherroute ,00	Predicted: Dummy_otherroute 1,00	Percentage Correct
Step 1	Dummy_otherroute	,00	74	278	21,0
		1,00	63	583	90,2
	Overall Percentage				65,8

a. The cut value is ,500

Appendix 13a: Classification table

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	56,362	15	<,001
	Block	56,362	15	<,001
	Model	56,362	15	<,001

Appendix 13b: Omnibus tests

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1239,252[a]	,055	,076

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than ,001.

Appendix 13c: Nagelkerke R square

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Geslacht			13,332	2	,001	
	Geslacht(1)	,515	,143	13,037	1	<,001	1,674
	Geslacht(2)	-,194	,762	,065	1	,799	,823
	Leeftijd			2,240	4	,692	
	Leeftijd(1)	-,710	,676	1,103	1	,294	,492
	Leeftijd(2)	-,381	,297	1,652	1	,199	,683
	Leeftijd(3)	-,211	,252	,701	1	,403	,810
	Leeftijd(4)	-,238	,240	,978	1	,323	,788
	Locatie(1)	-,186	,174	1,147	1	,284	,830
	Waarvoor			1,611	3	,657	
	Waarvoor(1)	-,047	,261	,033	1	,856	,954
	Waarvoor(2)	-,239	,266	,806	1	,369	,787
	Waarvoor(3)	-,115	,451	,065	1	,799	,891
	wat_voorfiets(1)	,316	,158	3,990	1	,046	1,372
	Bestemming(1)	,295	,211	1,960	1	,162	1,343
	Amount			3,748	3	,290	
	Amount(1)	,309	,172	3,222	1	,073	1,362
	Amount(2)	,270	,245	1,213	1	,271	1,310
	Amount(3)	,285	,363	,615	1	,433	1,329
	Constant	,550	,356	2,380	1	,123	1,733

a. Variable(s) entered on step 1: Geslacht, Leeftijd, Locatie, Waarvoor, wat_voorfiets, Bestemming, Amount.

Appendix 13d: Variables in the equation

Appendix 14: Regression model for the statement: I choose another transport mode, when I have to pass this location.

Classification Table[a]

Observed			Predicted: dummy_othermode ,00	Predicted: dummy_othermode 1,00	Percentage Correct
Step 1	dummy_othermode	,00	575	52	91,7
		1,00	182	77	29,7
	Overall Percentage				73,6

a. The cut value is ,500

Appendix 14a: Classification table

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	138,174	15	<,001
	Block	138,174	15	<,001
	Model	138,174	15	<,001

Appendix 14b: Omnibus tests

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	932,505[a]	,144	,206

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than ,001.

Appendix 14c: Nagelkerke R square

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Geslacht			4,939	2	,085	
	Geslacht(1)	,361	,168	4,616	1	,032	1,435
	Geslacht(2)	-,296	,850	,122	1	,727	,744
	Leeftijd			2,329	4	,675	
	Leeftijd(1)	-,013	,675	,000	1	,984	,987
	Leeftijd(2)	,093	,354	,069	1	,792	1,098
	Leeftijd(3)	,250	,284	,773	1	,379	1,284
	Leeftijd(4)	-,040	,270	,022	1	,882	,961
	Locatie(1)	-1,074	,207	26,902	1	<,001	,342
	Waarvoor			7,289	3	,063	
	Waarvoor(1)	,342	,271	1,598	1	,206	1,408
	Waarvoor(2)	-,079	,284	,078	1	,780	,924
	Waarvoor(3)	,765	,481	2,525	1	,112	2,148
	wat_voorfiets(1)	-,257	,188	1,875	1	,171	,773
	Bestemming(1)	,304	,223	1,870	1	,172	1,356
	Amount			30,638	3	<,001	
	Amount(1)	,378	,196	3,703	1	,054	1,459
	Amount(2)	1,118	,251	19,924	1	<,001	3,060
	Amount(3)	1,558	,380	16,825	1	<,001	4,751
	Constant	-1,047	,392	7,157	1	,007	,351

a. Variable(s) entered on step 1: Geslacht, Leeftijd, Locatie, Waarvoor, wat_voorfiets, Bestemming, Amount.

Appendix 14d: Variables in the equation

Appendix 15: Regression model for the statement: I have no alternative route or means of transportation to avoid this place.

Classification Table[a]

			Predicted		
			Dummy_no_otherchoice		Percentage Correct
Observed			,00	1,00	
Step 1	Dummy_no_otherchoice	,00	105	251	29,5
		1,00	73	508	87,4
	Overall Percentage				65,4

a. The cut value is ,500

Appendix 15a: Classification table

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	67,972	15	<,001
	Block	67,972	15	<,001
	Model	67,972	15	<,001

Appendix 15b: Omnibus tests

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1176,426[a]	,070	,095

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than ,001.

Appendix 15c: Nagelkerke R square

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Geslacht			8,642	2	,013	
	Geslacht(1)	,422	,145	8,442	1	,004	1,525
	Geslacht(2)	,608	,894	,462	1	,497	1,836
	Leeftijd			26,672	4	<,001	
	Leeftijd(1)	,231	,712	,105	1	,745	1,260
	Leeftijd(2)	-1,128	,310	13,269	1	<,001	,324
	Leeftijd(3)	-,041	,260	,025	1	,874	,960
	Leeftijd(4)	-,081	,246	,109	1	,742	,922
	Locatie(1)	-,093	,184	,258	1	,612	,911
	Waarvoor			5,105	3	,164	
	Waarvoor(1)	,553	,263	4,438	1	,035	1,739
	Waarvoor(2)	,542	,265	4,170	1	,041	1,719
	Waarvoor(3)	,212	,438	,233	1	,629	1,236
	wat_voorfiets(1)	,319	,164	3,787	1	,052	1,375
	Bestemming(1)	,282	,218	1,679	1	,195	1,326
	Amount			9,836	3	,020	
	Amount(1)	-,302	,176	2,956	1	,086	,739
	Amount(2)	-,708	,236	9,001	1	,003	,493
	Amount(3)	-,431	,377	1,307	1	,253	,650
	Constant	,080	,371	,046	1	,830	1,083

a. Variable(s) entered on step 1: Geslacht, Leeftijd, Locatie, Waarvoor, wat_voorfiets, Bestemming, Amount.

Appendix 15d: Variables in the equation