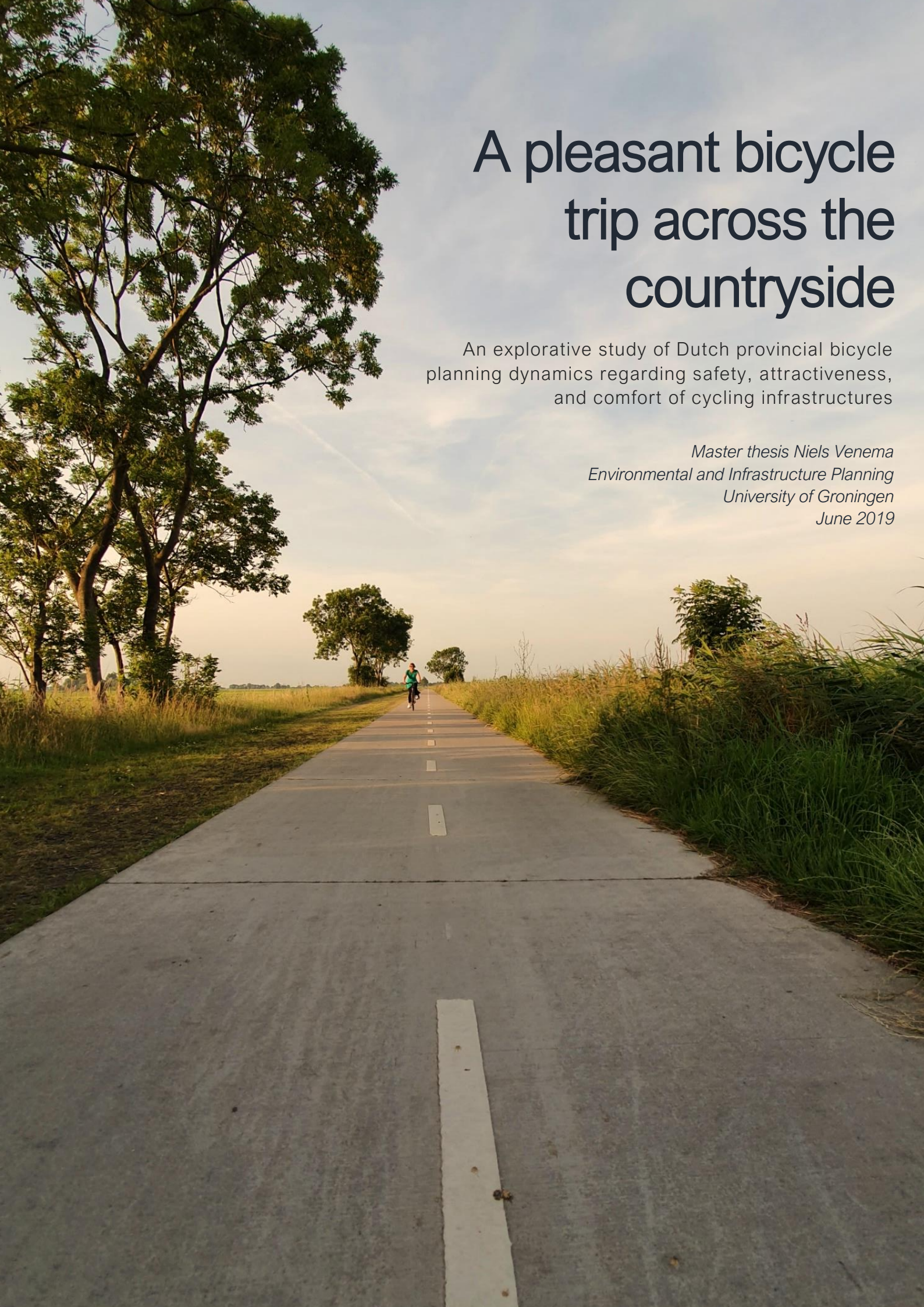

A pleasant bicycle trip across the countryside

An explorative study of Dutch provincial bicycle planning dynamics regarding safety, attractiveness, and comfort of cycling infrastructures

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Abstract

This study examines the perceived safety, attractiveness, and comfort of rural cycle routes. Essentially, two questions are to be answered: how do practitioners interpret safety, attractiveness, and comfort? And how do they deal with the ambition-implementation dynamics within the prioritisation of these three principles throughout the process? First, a solid theoretical basis is constructed that comprehensively describes how a cycling infrastructure can be made safe, attractive, and comfortable for the commuting cyclist. Then, five fast cycle route projects in the Netherlands are examined in two ways. First, by performing a document analysis, information is obtained about how practitioners interpret and rank all five principles for designing a cycle route (directness, cohesion, safety, attractiveness, and comfort). Second, interviews with practitioners that have been working on those projects are performed to obtain information about how those principles are interpreted, approached, prioritised, and implemented throughout the entire planning process. It is concluded that practitioners' interpretation is similar to theoretical views, although perceived safety is not considered as important in practice compared to theory. Furthermore, there are dynamics within the prioritisation of safety, attractiveness, and comfort throughout the planning process. Practitioners put a lot of effort into dealing with those dynamics and thereby give priority to all principles that make a fast cycle route unique. To make this happen, persistence, a no-nonsense strategy, and political guts are essential in the planning process.

List of figures and tables

Figures:

Tables:

Keywords

Infrastructure planning; cycling; sustainable mobility; planning processes; fast cycle routes

Abbreviations

CBS:	Centraal Bureau voor de Statistiek (Dutch Statistics Office)
HOV:	Hoogwaardig Openbaar Vervoer (High-quality Public Transport)
KiM:	Kennisinstituut voor Mobiliteitsbeleid (Knowledge Institute for Mobility Policy)
OV:	Openbaar Vervoer (Public transport)
PRESTO:	Promoting Cycling for Everyone as a Daily Transport Mode
RAI:	Rijwiel- en Automobiel-Industrie (Bicycle and Automotive Industry)
RUCA:	Rural-Urban Communing Area
SCP:	Sociaal Cultureel Planbureau (Social Cultural Planning Office)
SWOV:	Stichting Wetenschappelijk Onderzoek Verkeersveiligheid (Scientif. Research Road Safety)
TPB:	Theory of Planned Behaviour
USDA:	United States Department of Agriculture

Table of contents

1. | Introduction

Nowadays, sustainable modes of transport receive special attention in the light of decarbonising human society. One of the alternatives is cycling, which is a popular mode of transport in the Netherlands, with the electric bicycle becoming an even more prominent user of the cycle path. Together with the trend of decreasing public transport provision in low-population density areas in the Netherlands (KiM, 2015), this leaves an opportunity for the (electric) bicycle to bridge the distance between origin and destination (Fishman and Cherry, 2015). With the increase in electric bicycle users, cycling longer distances becomes more common nowadays (KiM, 2016). In this way, the bicycle now has better odds to outplay the car regarding travelling in a rural environment, for example by using fast cycle routes that connect major towns. Still, this asks for cycle-friendly spatial planning in rural areas.

Cycling has many advantages, which are affirmed by the Dutch cycling culture. The Netherlands is the most bicycle-intensive country in the world, being the absolute number one regarding the share of cycling in the total number of trips. Furthermore, the Dutch inhabitants own 1,3 bicycles on average (KiM, 2018). Besides that, cycling is considered as the optimal mode of transport, because it is healthy, environmental-friendly, and efficient (Badland and Schofield, 2008). For these reasons, you would expect a fully-fledged facilitating cycling infrastructure, especially in the Netherlands, to make cycling fully institutionalised in the transportation culture. Most major Dutch cities are indeed well known for its cycling infrastructure, and cycling as a mode of transport is embedded in the urban culture. However, in rural areas there are quite some practical elements that are not so much appreciated, such as too narrow cycle paths, speeding cars passing by too close, bollards, unclear crossings, traffic lights, nuisance from agricultural traffic, and the feeling of unsafety (Provincie Gelderland, 2018; Provincie Groningen, 2016), let alone the stronger influence of bad weather conditions. These rural cycling infrastructures are under investigation in this study.

Currently, many Dutch provinces are making an effort to increase cycling by developing 'fast cycle routes' that connect major villages and cities by creating long, straight, and broad cycle paths (Provincie Groningen, 2016; Provincie Gelderland, 2019; Provincie Noord-Brabant, 2016; Provincie Zuid-Holland, 2016). Although routes being fast and short is essential, some routes score high, while other score low (see ANWB research on Dutch fast cycle routes, 2019). These fast cycle routes ask for a broad range of criteria to be fulfilled in order to be successful. To get straight to the point, the experience of cycling and its surrounding landscape are just as important as the time the journey takes. In other words: not only the fastest or shortest route, but also the safest or most appealing route is chosen (Plazier et al., 2018; Krenn et al., 2014; Mossel, 2018; Provincie Gelderland, 2018). Thus, the surroundings are an important element during a cycle trip. Cyclists and their environment have a strong interaction (Vivanco, 2013; Te Brömmelstroet et al., 2017). The people-environment interaction while cycling is different from the people-environment interaction during a car trip, where the interaction is reduced to the two-dimensional view through the windscreen (Sheller and Urry, 2000). Therefore, the development of the infrastructure itself together with its surroundings, rather than a traditional focus on solely infrastructure, has to receive particular attention in bicycle planning. This is also called an area-oriented approach (Heeres et al., 2012), which is - consequently - of importance for bicycle planning and will be elaborated on later.

Thus, cycling infrastructure policies should not only aim at a fast and efficient cycling infrastructure, but also at elements that make the cycle trip itself pleasant, such as safety, attractiveness and comfort. It is striking that the urban policy makers are relatively successful in bicycle planning, while rural bicycle infrastructure planning is not thriving in comparison to urban areas (Provincie Gelderland, 2018; Provincie Groningen, 2016). Further deploying the potential of active transportation modes in rural areas is realistic, especially for electric bicycles (hereafter called 'e-bike'). Namely, car users in rural areas are more willing to use an e-bike than current regular bicycle users (Plazier et al., 2018). To do this, specific public policies should be directed towards enhancing the cycling infrastructure. According to Pucher et al. (2010), this can have successful outcomes, if done in a proper way: cycling can be stimulated by developing policies aimed at particular physical measures, such as separate cycle lanes and providing sufficient facilities (Pucher et al., 2010). How the process of enhancing the cycling infrastructure takes place in the Netherlands is explored in this study.

1.1. Cycle trends

Facts about cycling show that indeed not the full potential travellers that are able to cycle do cycle. While people are, on average, willing to travel up to 7,5 kilometres on a regular bicycle (KiM, 2016), only 35% of trips up to 7,5 kilometres is actually done on a bicycle (Ministry of Transport, Public Works and Water Management & Fietsberaad, 2009). This number decreases to 15% for trips between 7,5 and 15 kilometres (Ministry of Transport, Public Works and Water Management & Fietsberaad, 2009), which is the distance people are willing to travel on an e-bike (KiM, 2016). On a world scale, though, these numbers are relatively high. Still, when keeping in mind that only 35% of trips up to 7,5 kilometres is made on a bicycle, there is a potential of 65% to be filled in, theoretically, as 65% still does not cycle. In addition, there are many commuters who alternate their mode of transport. In other words, they do ride a bicycle to work, but choose the car or public transport in some cases as well (Ministry of Transport, Public Works and Water Management & Fietsberaad, 2009). Thus, certain factors refrain travellers to take the bicycle, possibly frightened by the feeling of an unsafe and uncomfortable cycle trip. Although it is assumed that cyclists are more likely to alternate their transport mode - they are more susceptive to the dynamic environmental conditions (Heinen, 2011) - this also suggests that they are easily influenced by the environment and can therefore be turned into a 'full-time cyclist' by offering them a comprehensive infrastructure.

Unsafety can indeed be observed as a trend in cycling in the past years. The behaviour of cyclists is changing due to the presence of e-bikers on the cycle path. Overtaking and crossing is now different than ten or fifteen years ago. Since the infrastructure is lacking, dangerous situations emerge which can lead to more accidents (Smit-van Oijen et al, 2013). Besides the perceived safety, also facts about the actual safety show that cycling is not the safest mode of transport in the Netherlands. Between 2000 and 2014, the share of cyclists in the total of serious traffic injuries increased from 29% to 52%. In addition, most of these injuries are the result of unilateral accidents (CBS, 2016). In other words: accidents where no other vehicle was involved, but collisions with obstacles or cyclists falling off their bike, contribute greatly to the total of serious traffic injuries. This is striking since cycling only has a marginal contribution to all traffic movements. Of the total distance travelled by all people in the Netherlands, only 9% is done on a bicycle. When looking at the total time travelled, the share of cycling is 21% (CBS, 2016).

The high number of accidents among cyclists may have two causes. First, cyclists are vulnerable. It is more difficult to protect cyclists than for example car drivers. This is in two ways: cyclists are vulnerable in terms of perceived safety (they feel unsafe) and in terms of actual safety (number of accidents, fatalities and injuries) (Heinen et al., 2010; Cho et al., 2009). Both perceived and actual safety are related to the built environment (Cho et al., 2009). The low actual safety is especially true for the elderly. 63% of traffic fatalities is someone older than 65 years on a bicycle. With the ageing population, it is expected that this number will even increase in the upcoming years (CBS, 2016). How big the role of the infrastructure is in this part is open for discussion, but it is clear that the cycling infrastructure needs to facilitate an increasing number of elderly on an (electric) bicycle.

As mentioned earlier, the type of bicycles on the bicycle paths is changing, with the rise of the e-bike. The number of e-bikes in 2017 was over 1,9 million, compared with 22,8 million bicycles in total (RAI Vereniging, 2018). In 2018, the e-bike was the type of bicycle that has been sold the most of all categories, where the ordinary city bicycle has been knocked off the throne as the most sold bicycle (RAI Vereniging, 2019). The cycling infrastructure needs to facilitate the higher speeds that these e-bikes can reach, in order to enhance safety and comfort levels of cycling.

1.2. Five essential principles for cycling infrastructures

To become cycle-friendly, five principles are essential to be taken into account. These principles are initially developed by the Dutch infrastructure knowledge and expertise platform CROW, but nowadays used and appreciated by many academic authors (e.g. Zhao et al., 2018). CROW is well-known for its development of guidelines, rules, tools and education for infrastructure, public space and mobility. Although they have no legal status, their work is often used in practice. The principles developed by CROW are *directness,*

cohesion, safety, attractiveness, and *comfort* (CROW, 2006). According to Hull and O'Holleran (2014), these principles are essentially appropriate for exploring the current state of bicycle infrastructure planning and for identifying its strengths and weaknesses. The first two elements (directness and cohesion) are related to the time to go from A to B, and whether or not cycle paths are located near specific locations, such as public transport hubs (see section 2.4 and 2.5). These two factors are important in the decision on whether people take their bicycle or not. For example, origin and destination should be close enough to make it even possible to bridge the distance at all. As already mentioned in the intro, practice shows that there is much emphasis on fulfilling these principles. Still, it is just as valuable to look at the other three principles as well, which are just as important. Thus, in cases when the directness and cohesion are not restraining the potential cyclist from cycling, it is valuable to look at safety, attractiveness, and comfort. These elements focus more on the people's perspective, which is important for area-oriented planning (see also 'sustainable mobility paradigm' by Banister, 2008). To illustrate that this perspective is essential, the research of Vedel et al. (2017) in Copenhagen found that people are willing to cycle an additional 1,84 kilometres when they have a designated cycle track, and 0,80 kilometres if the surroundings are more appealing. For the above-mentioned reasons, the main focus of this research is on further investigating these three factors and how they are interpreted and implemented. A short description of each is given below.

- Safety: Traffic safety of cyclists and other road users.
- Attractiveness: The cycling infrastructure and its surroundings invite the traveller to take the bicycle.
- Comfort: The cycling infrastructure enhances a non-stop and comfortable flow of cyclists.

(CROW, 2006)

The principles were developed in 2006, which makes it over a decade old. During this decade, bicycle transportation has changed significantly, with the rise of the e-bike being the most prominent change. Therefore, as a first step, it is valuable to obtain new insights in bicycle users' needs regarding these principles.

Intersubjectivity

An important caveat should be taken into account related to the five cycling principles. Many authors write about the subjectivity of the outside world, such as De Roo (2003). As one of the focusses of this research is on the cycling infrastructure and how the user experiences this infrastructure, it is important to look at the differences in perceptions: the intersubjectivity. For the understanding of safety, attractiveness, and comfort, it is essential to examine this term. It is about the intersubjective and interactive context where the subject (in this case the cyclist) and object (the infrastructure and environment) interact, to form value judgements (De Roo, 2003). This is of importance for this research, since for safety, attractiveness, and comfort during a cycling trip, value judgements about what these three terms entail are a point of discussion. In other words: there is no common agreement on what is perceived as safe, attractive, and comfortable. Still, this does not mean that no generic principles or guidelines can be obtained by studying literature. How this is done is described in the following sections.

1.3. Research problem, aim, and rationale

1.3.1. Problem definition

Currently, cycling in a rural environment is not as pleasant as people wish it would be. Cyclists experience cycling as unsafe and uncomfortable (Provincie Gelderland, 2018; Provincie Groningen, 2016), which means that the perception of cycling is unsatisfactory. Also actual facts about safety show that the cycling infrastructure leaves much to be desired (CBS, 2016). With the ageing population and the rise of the e-bike, cyclists' demands are constantly changing. This leads to a cycling infrastructure that is lacking and obsolete, leading to a gap between the actual number of commuters cycling, and the potential number.

Although intersubjectivity and context-sensitivity plays a role in determining what a cycle-friendly infrastructure entails, there are many theories available which describe what specific physical measures for cycling infrastructures do attract commuters and which do not. Out of this, a guiding framework can be

developed that takes cyclists' (perceived) safety, attractiveness, and comfort into account. Thus, a 'generic' or 'ideal' cycling infrastructure does not exist because context plays a major role. Nevertheless, this means that it is interesting to explore different Dutch cycling infrastructure projects, what approaches they use in bicycle planning (e.g. area-oriented vs. infrastructure-oriented) and thereby look at whether cycling infrastructure theories have similarities or differences with reality. This research therefore aims to investigate to what extent the theoretical suggestions about the cycling infrastructure align with the planning practice of the Netherlands, and to what extent this practical interpretation changes throughout the planning process. For example, it can be the case that comfort is considered important in the ambitions phase of a project, but not important during the final plan development. First, a solid framework is needed which includes suggestions about developing a cycle-friendly cycling infrastructure from a commuter's perspective. This is done by the use of scientific articles. Thus, there are three 'layers' to be explored in this research: First, academic literature about the perceptions of a safe, attractive, and comfortable cycling infrastructure and its immediate vicinity. Second, the inclusion of those principles in Dutch planning documents (i.e. project documents, plan decision documents, zoning plans). Third, the practical reality of safety, attractiveness, and comfort, including its potential prioritisation dynamics throughout the planning process. From these three layers, the following main research question can be formulated:

"How do Dutch planners approach the planning of rural fast cycle routes and its immediate vicinity in their policies and throughout the entire planning process, regarding safety, attractiveness, and comfort?"

To answer this question in a complete and coherent way, several steps are necessary to be taken. The first step is to explore and dive into layer one: the perceptions of safety, attractiveness, and comfort in a cycling infrastructure, according to academic literature. This is done in the theoretical framework. After that, practical reality is examined. Thus, a link is sought between scientific knowledge and bicycle planning practice. The following three sub questions are used as a guide for answering the main question:

- "How are safety, attractiveness, and comfort getting attention in Dutch bicycle plan decision documents in relation to directness and cohesion?"
- "How are safety, attractiveness, and comfort approached and implemented in Dutch bicycle planning practice?"
- "How do the planners deal with potential prioritisation dynamics throughout the planning process?"

These three sub questions are answered with knowledge from the Dutch planning practice by studying bicycle plan decision documents of bicycle infrastructure projects (fast cycle routes in the Netherlands) and by performing interviews with people involved in the plan and decision-making of these specific projects.

1.3.2. Research rationale

This research is scientifically relevant for several reasons. Firstly, the world of cycling is constantly changing with especially the rise of the e-bike (RAI Vereniging, 2018; 2019). This makes it necessary to develop an actual framework that gives an accurate overview of suggestions for cycle-stimulating measures regarding safety, attractiveness, and comfort. This can contribute to future research on cycling infrastructures. Secondly, the focus is specifically on the rural cycling infrastructure, while much scientific research about cycling focuses on the urban cycling infrastructure. About spatial planning processes in the rural cycling infrastructure, less knowledge is currently available, especially in the European context. This research will therefore fill in the knowledge gap regarding cycling in a rural environment. Thirdly, lots of studies focus on the infrastructure itself rather than the surroundings of the infrastructure, and the experience (Plazier et al., 2018; Krenn et al., 2014; Mossel, 2018). The study of Koglin (2015) concludes that an area-oriented approach - a broad focus on infra and surroundings rather than narrowing it down to solely infrastructure - has positive implications for cycling activities. Because of that, this research focuses on the optimal combination of both the infrastructure itself as well as the surroundings, by paying special attention to the spatial planning approaches used in this sense by the Dutch provinces. Fourth, fast cycle routes are booming and knowledge is constantly developing. Fast cycle routes need a decent planning process since

they need to be of a sufficient quality to attract a substantial number of cyclists, while these kind of projects also have a significant impact on the spatial quality of the landscape. This research will therefore provide advices on how to best address the planning process of fast cycle routes in order to make them successful.

Societally speaking, the relevance of this research mainly comes from the main benefits of cycling in general. According to McAndrews et al. (2018), many planners promote cycling as a way to reduce the car dependency and to increase the physical activities of citizens, also in low-density areas. This research can help these planners by giving advice about which physical principles of the cycling infrastructure and its immediate vicinity indeed promote cycling as a mode of transport. The societal aim of this research is therefore to make people cycle more, as it is a healthy, environmental-friendly, and efficient mode of transport (Badland and Schofield, 2008). Furthermore, the focus on commuters has two benefits in particular, First, effective reduction of nuisance from traffic congestion and the subsequent high air pollution concentrations is possible. Namely, commuters are the core group to target when it comes to reducing traffic congestion (Heinen et al., 2010). Second, it is argued that daily exercise is more beneficial for health on the long term than activities with another frequency (Lawlor et al., 2003). As commuting often occurs on a daily basis, this can contribute to the health of society in general.

The results of this research can thus be of importance for spatial planners and policy makers who aim to improve their cycling infrastructure in terms of perceived safety, attractiveness, and comfort. Many spatial plans regarding cycling used to aim to make cycle routes as fast as possible (e.g. 'cycle highways' or 'fast cycle routes', Provincie Groningen, 2017; Provincie Gelderland, 2019[a]), while also sufficient attention needs to be given to safety, attractiveness, and comfort. Nowadays, there is a shift to focus more on these three aspects (Godefrooij and Van Goeverden, 2010), especially due to the popular sustainable mobility concept as proposed by Banister (2008). He states that sustainable mobility developments such as cycling should be focused on the people's side (e.g. why do people travel?) and on the spatial quality, rather than more hard measures such as minimising travel time or distance. In this way, public acceptance of sustainable modes of transport will be successful (Banister, 2008). Therefore, this research adds the underlying forces behind safety, attractiveness, and comfort (the people's side) to planning practice. It gives information about what specific physical elements can be used in planning practice to enhance the cycling infrastructure, especially for the e-bikers. In addition, the value judgements about what is perceived as safe, attractive, and comfortable are given special attention and can therefore be defined better, which is useful for further use in spatial planning studies. Additionally, the practical experiences of planners involved in rural cycling infrastructure projects can be used for future planners, in order to make their projects successful. How can the planning of cycle routes be improved in order to enhance rural cycling? And what lessons can be learned from practice in order to improve those processes? These are questions than can be answered with the help of this research, both by theoretical and practical knowledge. The theoretical side is explored in the next chapter.

2. | Theoretical Framework

This chapter will dive into the driving forces of commuter's cycling activities. First, a general overview is given of all factors that influence cycle behaviour, ranging from socio-economic to physical factors (section 2.1). After that, the rural environment, a cycling infrastructure and its immediate vicinity are defined (section 2.2). Section 2.3 elaborates on the area-oriented planning theories, applied to cycling infrastructure planning practice. In sections 2.4 and 2.5, directness and cohesion are given more meaning briefly. Sections 2.6, 2.7, and 2.8 extensively review the literature about safety, attractiveness, and comfort. Then in section 2.9, the theoretical ranking of the five CROW principles are discussed. Finally, section 2.10 presents an overall conceptual model, visualising the entire theoretical framework for this research.

2.1. What makes people cycle? A general overview

Cycling activities among commuters is influenced by a comprehensive range of factors. Among these are spatial elements, weather, climate, policies, office conditions, image, attitude, and socio-demographic and cultural factors (Ajzen, 1991; Pucher et al., 1999; Stinson and Bhat, 2005; De Geus, 2007; Heinen et al., 2010). For Dutch cities for example, it is argued that cycling has become popular due to a combination of several kinds of factors: (1) cultural: the positive image of and attitude towards cycling in general among Dutch people; (2) spatial: the Dutch cities being compact cities; and (3) policies: bicycle stimulating policies in the 1970s and 1980s increased cycling shares significantly in the years after (Bruhéze and Veraart, 1999). What these policies entail can range of course from physical measures to more social or financial measures.

To start off, attitude is one of the main drivers of cycling. According to Ajzen (1991), attitude is about the value and importance that travellers attach to using a particular transport mode, in this case cycling. Thus, someone can attach a positive value to a cycle trip since it is healthy, or a negative value since the bicycle route to his or her destination is very unsafe. About health, there are indeed indications that the subsequent benefits of cycling attract people to use the bicycle (Gatersleben and Appleton, 2007). The same holds for caring about the negative consequences of car use (Stinson and Bhat, 2005), such as environmental and health-related consequences. Relating to individual attitude, social norms can also play a key role in cycling behaviour. People behave in a way to fit within certain social groups, also for cycling activities (see also the 'theory of planned behaviour' (TPB), Ajzen, 1991). When having more social support for cycling, people's attitude towards cycling is more positive, which leads to a higher share and frequency of cycling as a mode of transport (De Geus, 2007; Pucher et al., 1999). It is also concluded by De Geus (2007) and Gatersleben and Appleton (2007) that people who do not cycle have a more negative image of cycling than people who do cycle. For example, car users see more barriers, while these barriers are not perceived by cyclists. This phenomenon derives from the perceived behavioural control, falling under TPB (Ajzen, 1991).

There are several sociodemographic factors that determine cycling activities. One of them is gender. Several studies argue that women cycle less than men, both in terms of distance and frequency (Garrard et al., 2008; Dill and Voros, 2007). The effect differs however depending on the cycling culture of the country under study. Cycling becomes only popular for women when cycling is a popular mode of transport, such as in the Netherlands (Garrard et al, 2008). About age, different conclusions are found. Some state that age and cycling activities are in a negative relationship, i.e. cycling activities decrease with age (Pucher et al., 1999); Moudon et al., 2005); Dill and Voros, 2007). Others (De Geus, 2007; Wardman et al., 2007) did not find this relationship. With the e-bike becoming a more popular mode of transport, especially among the elderly, it can indeed be questioned whether age has a significant influence on cycling activities nowadays.

Car ownership is also a good indicator of the mode share of cycling: increasing car ownership lowers cycling frequency (Stinson and Bhat, 2004). This is of course dependent on several factors, such as transportation culture. Furthermore, the costs of other transportation modes are an important determinant for whether people cycle. Pucher and Buehler (2006) for example argue that the high costs of other modes increase cycling activities. The same holds for the fact that cycling is relatively cheap (Bergström and Magnussen, 2003). Also, making public transport free reduces cycling activities (Bamberg et al., 2003).

The type of household and / or employment status says something as well about the cycling activities. Moudon et al. (2005), Ryley (2006), and Rietveld and Daniel (2004) did a study regarding these factors in the US, the UK, and the Netherlands respectively. They found that people with children cycle the least, just as people with a high social status (<6,4%) or high education (Rietveld and Daniel, 2004). People that are in between jobs (11%) and part-time workers without children (8,1%) cycle more than the average, while students (17,9%) and people without children (16%) cycle even more (Moudon et al., 2005; Ryley, 2006).

Besides the factors relating to individuals, also external factors are determinants whether to cycle or not. These can be posed by both governmental and non-governmental organisations. In the case of governmental, examples are policies that either stimulate cycling (e.g. financial incentives), or restrict other modes of transport (e.g. car driving taxes), often referred to as the carrot and the stick, respectively (Davy, 2012). Non-governmental organisations, such as private companies, can offer their employees physical facilities (e.g. bicycle lockers, showers) or financial incentives that seduce them to cycle to work. Office norms play an essential role here (Heinen, 2011). This is in turn related to the social norms in general (De Geus, 2007). Social norms and office norms overlap, which means that positive social norms about cycling can induce positive office norms about commuting by bicycle.

Lastly, we come to the spatial characteristics, which is the main focus of this research. Regarding travelling, and cycling in particular, distance is a major factor. Increasing distance means a lower chance of cycling (Pucher and Buehler, 2006). The same holds for a comprehensive cycle network which brings Euclidean distance and network distance closer together (Southworth, 2005). Pucher (2001) investigated whether cycle friendly infrastructures have an impact on the cycling activities of countries. He found that higher modal splits of cycling can be related to a high number of cycling facilities. How a cycle-friendly infrastructure looks like is elaborated on in detail in the following sections.

One should acknowledge that all factors mentioned above could be either necessary or restricting when someone makes the decision to cycle. It is neither possible within the timescale of this research nor effective to investigate in more detail what all these factors entail. Furthermore, the physical cycling infrastructure should not be seen as a separate entity, but rather as the physical representation of the local, regional or national cycle culture and to what degree efforts are made by governments to stimulate cycling.

As a first step, more literature research is needed to further explore and define the physical rural cycling infrastructure. A cycling infrastructure does not solely consist of cycle paths, but is linked with its surroundings (Vedel et al., 2017). Scientific literature is therefore needed to demarcate what a cycling infrastructure entails, and what its immediate vicinity entails. Thus, the relation between the cycling infrastructure and the surroundings is important to consider. Hence, it is valuable to look at area-oriented approaches as a concept for these infrastructural developments, which is done in section 2.3. The five principles for cycle-friendly infrastructures (directness, cohesion, safety, attractiveness, and comfort) will be deepened out further in the subsequent sections, where safety, attractiveness, and comfort receive special attention. Since the five elements overlap each other on certain aspects, several linkages between the sections will be made.

2.2. Defining a rural cycling infrastructure and its micro-environment

2.2.1. Rural

Since this research is focused on the rural cycling infrastructure, it is important to explicitly define and demarcate what ‘rural’ entails. The Cambridge dictionary tells us that rural is simply everything “in, of, or like the countryside” (Cambridge Dictionary, 2019). However, this is a quite broad definition and, according to Hart et al. (2005, p. 1149), rural is rather “a multifaceted concept about which there is no universal agreement”. First of all, demographic, economic, and environmental characteristics can vary a lot over different rural areas. The distance to cities for example is an important factor determining the kind of area or town. Hart et al. (2005) give several classification methods, of which one is focused on transportation.

According to the Rural-Urban Communing Area (RUCA) codes, an area is defined as rural when the primary flow of traffic is to an area outside of this particular area, for example another municipality or town (census tract) (USDA, 2016). Theoretically, this is a clear definition, but it is not so straightforward in practical reality. Defining an area is one of the barriers to overcome when applying this definition. A more straightforward definition can be derived from the CBS, which has a five-class classification for 'degree of urbanisation' for each postal code area, including: 'very strongly urban' (more than 2500 addresses per km^2), 'strongly urban' (1500-2500 addresses per km^2), 'moderately urban' (1000-1500 addresses per km^2), 'little urban' (500-1000 addresses per km^2), and 'non-urban' (less than 500 addresses per km^2) (SCP, 2006). The SCP (Dutch Institute for Social Research) and the CSB considers the latter two classes (little urban and non-urban) as rural, since here there are less than 1000 addresses per km^2. To make this concrete: in this way, 71,5% of the Netherlands is considered as rural (SCP, 2006).

2.2.2. Cycling infrastructure and the immediate vicinity

Cycling infrastructure

Although cycling infrastructures exist in various ways, they are defined relatively straightforward. Heinen et al. (2010) defines it as the collection of separate bicycle paths, bicycle lanes (on-street) and common streets where it is allowed to cycle. Regarding these different forms of the cycling infrastructure, it can be stated confidently that the cycling infrastructure is a very important determinant for attracting cyclists (Heinen et al., 2010), together with its bicycle facilities, such as racks, lockers and charging spots. Regarding the cycle routes themselves, the European Union's PRESTO Cycling Policy Guide on Infrastructure by Dufour (2010) classifies cycling routes in three levels, which are: (1) Main routes: the routes that connect major places within cities, between cities, towns, and villages, both inside and outside the built environment; (2) Top local routes: these routes are at the heart of the urban area, where they connect districts and major urban areas; (3) Local routes: include the other routes not includes in (1) or (2) that can be used by cyclists, i.e. accessing neighbourhoods, buildings, and other higher level routes (Dufour, 2010). It can be assumed that a good combination of the three categories of routes helps in developing a solid and comprehensive cycling infrastructure.

A specific type of a cycling infrastructure is a fast cycle route, which is defined as a separate, wide, and comfortable cycle route that connect towns and cities on a regional scale. These routes are especially developed to enhance the accessibility of residential and work locations in order to make people cycle instead of use the car (Fietsersbond, 2019). One can especially think of trips longer than 7,5 kilometres, but also shorter trips that are currently made by car can be made on a bicycle and therefore benefit from fast cycle routes.

Notwithstanding, the cycle experience is not only influenced by the physical cycling infrastructure itself, but also by its surrounding area. This is discussed below.

Immediate vicinity

When speaking about the physical environment in general, a classification can be made of two types of environments: macro-environments and micro-environments. Macro-environments are characterised by the more broader facts about densities (street network density, housing density) and land use. Micro-environments are the more specific small-scale environmental factors, such as the cycle path itself, whether it is separated from motorised traffic, the presence of vegetation, speed limits, and the surrounding land-uses. These factors can be modified by individuals or local actors (Swinburn et al., 1999; Cain et al., 2014). The cycling infrastructure and its immediate vicinity can thus be defined by the micro-environment. Generally, macro-environmental factors are more difficult to change than micro-environmental factors because of its complexity (e.g. many actors) and size (Swinburn et al., 1999; Cain et al., 2014). Still, the interrelatedness of the micro-environment with other micro-environments and its broader macro-environment makes interventions often not an easy task. The next section describes how spatial planning processes of infrastructure development could integrate with the demands of its micro-environment.

2.3. Area-oriented spatial planning in cycling infrastructure development

Cycling infrastructure planning is not a process standing on its own. It has interlinkages with the surroundings, as described in the previous section. Making a cycling infrastructure more safe, attractive, and / or comfortable therefore requires a well-guided spatial planning process. Since cycling infrastructures can both be a local (municipal) and regional (provincial) entity, the planning of these infrastructures need to be integrated with the local and regional functions, such as other infrastructural works (local roads, highways), agricultural areas, natural areas or (low-density) residential areas, which all in turn have their own stakeholders and interests (Heeres, 2017). An *area-oriented approach*, as used in the past decades in particular, takes more account of these stakes and interests than the traditional *line-oriented approach*, that focuses only on infrastructure development (also referred to as sectoral planning, or planning in 'silos'). The spectrum between line-oriented and area-oriented approaches is shown in figure 1. The main reason for the rise of the area-oriented approach is that the growing complexity and dynamic processes of spatial planning were difficult to be dealt with by road planners. To be concrete, neo-liberalisation, the rise of the network society, environmental awareness, the effects of the economic crisis, and the higher demand for less available space were among the issues making spatial planning more complex and dynamic (Heeres et al., 2012; Arts, 2007). Taking into account a broader field of interests was seen as an appropriate response to these issues (Heeres et al., 2012). Nowadays, it can be observed that these issues have not been driven to the background. Rather, the opposite can be observed. Fortunately, cycling has some advantages over 'general' road planning (i.e. motorised traffic), which might possibly lower the complexity. The take-up of space is less than for the construction of a regular road, and the environmental externalities are minimal as air pollution and noise nuisance are not an issue for cycling. The increased environmental awareness would in the case of cycling infrastructure planning even be a stimuli instead of a constraint. For these reasons an area-oriented approach is chosen as the main focus of this research rather than area-development (see figure 1).

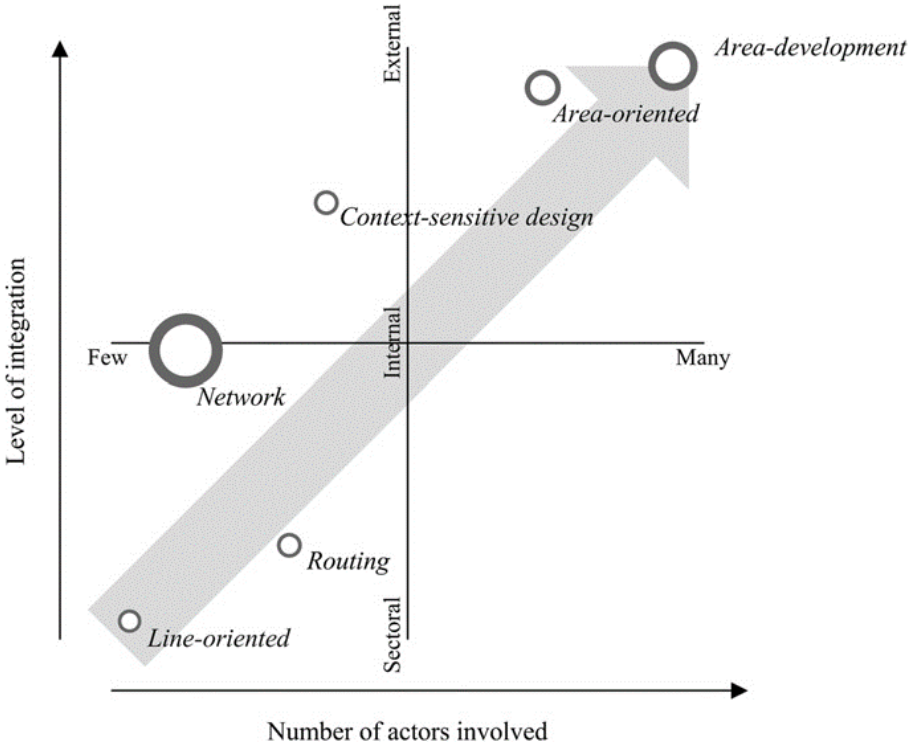

FIGURE 1: SPECTRUM SHOWING THE RELATION BETWEEN THE NUMBER OF ACTORS INVOLVED AND THE LEVEL OF INTEGRATION, AS PRESENTED BY HEERES ET AL. (2012). THE DOTS REPRESENT THE LEVEL OF SPATIAL FOCUS, WHICH RANGES FROM LOCAL (SMALL DOT) TO REGIONAL (BIG DOT).

Thus, area-oriented approaches take the demands and opportunities of the surroundings into account. The function and time scope of infrastructural projects should be broadened, in order to be more adaptive and flexible, and consequently keeping in mind a broader spectrum of possible alternatives. In other words, a synergy is sought between the cycling infrastructure and the surroundings, to aim for a higher spatial quality and sustainable development (Heeres et al., 2012). According to Koglin (2015), using such an area-oriented approach towards cycling infrastructure developments has positive outcomes on the modal share of cycling. From this it can be concluded that solely improving the cycling infrastructure itself is not the only solution. The *outside-in* perspective - seeing the infrastructure from the viewpoint of the surrounding area - can provide several additional alternatives which might help to increase the modal share of cycling as well (Arts, 2007; Koglin, 2015). The following five sections focus more on the perspective of the commuting cyclist (i.e. a viewpoint from infra towards area, the *inside-out* perspective), by discussing the five principles that are regarded as beneficial for cycle-friendly cycling infrastructures. However, again, after deepening out these principles, one will find out that the spatial planning processes that are required to meet the needs of these principles should definitely take the outside-in perspective and area-oriented approaches into account. Thus, ideally, cycling infrastructure developments are done from both the inside-out (infrastructure → area) and the outside-in perspective (area → infrastructure) (Arts, 2007), in order to make sure that they all can be tailor-made and area-oriented while maintaining a focus on the cyclist's demands. The area-oriented approach can therefore be considered as an overarching concept that guides the process for implementing measures regarding safety, attractiveness, and comfort, and directness and cohesion to a lesser extent. These measures are presented and discussed in the following five sections.

2.4. Directness

Directness is about offering the cyclist a route that is as short as possible, where detours should be left out as much as possible. This includes speed, delays, and the distance of possible detours. For example, when a particular journey by car is faster than by bicycle, it is very likely that the car is preferred over the bicycle. Logically, the same holds for when a bicycle is faster than the car (CROW, 2006). This is the main reason for why many provinces in the Netherlands are constructing fast cycle routes between major towns and cities, in order to let the bicycle be a good alternative for the car driver (Provincie Groningen, 2017; Provincie Gelderland, 2019[a]). The presence of delays or other nuisance while cycling is also part of the comfort of cycling, as discussed under section 2.7 - *Comfort*. In this way, improving the comfort of cycling could improve the directness simultaneously.

2.5. Cohesion

Besides having direct connections, the cycling infrastructure should be cohesive as well. Cyclists must be able to reach as much destinations as possible on a bicycle. In other words: origin and destination should be connected seamlessly. A destination in this sense could be a bus stop or train station as well, in order to make multimodality feasible. Cohesion is further enhanced by findability, consistence in infrastructure quality, and freedom of choice for which route to take (CROW, 2006). In order to reach as much destinations as possible on a bicycle, a cycling infrastructure should have a high level of continuity (Heinen et al., 2010). This means that, for example, cycle paths should not have sudden endings, but instead be continuous in their form (Stinson and Bhat, 2005). Here, cohesion has some overlap with both safety and comfort. Sudden endings of cycle paths are perceived as fairly unsafe (Stinson and Bhat, 2005, see section 2.5.3 - *What makes a road safe?*). The similarity with comfort is that comfort also means that a cycling trip should not ask for an irregular effort from the cyclist, and thus be continuous instead (CROW, 2006, see section 2.7 - *Comfort*).

2.6. Safety

According to CROW safety is defined as an infrastructure that guarantees the traffic safety of cyclists and other road users. Since cyclists have no extra protection themselves, which most other road users do have, they are more vulnerable and must be taken care of more explicitly (CROW, 2006). It is evident that a higher chance of accidents (either perceived or actual) leads to a lower bicycle share (Pucher and Buehler, 2006).

The cycling environment can therefore be designed in such a way that the circumstances of a cycling trip facilitate safety (CROW, 2006). Dufour (2010) adds to that, that safety is the "basic requirement and must be the overriding concern" (Dufour, 2010, p. 8). While cyclists themselves usually form no danger to other traffic, they are vulnerable when moving in the same area as motorised traffic, due to high differences in speed (Dufour, 2010). In this section, safety theories will be further explored and applied to the traffic safety of cyclists.

2.6.1. Actual safety vs. perceived safety

In spatial planning, there is a classification of actual safety and perceived safety. Actual safety can broadly be defined by the number of accidents, fatalities and injuries, for example per million inhabitants (Heinen et al., 2010). Perceived safety is a more subjective view on safety: how safe do cyclists feel while cycling? (Cho et al., 2009). Both actual safety and perceived safety can be similar for a certain place, but also differ strongly on another place (Heinen et al., 2010). When talking about cycling specifically, it seems that, from the cyclist's perspective, the perceived safety posed by the bicycle infrastructure facilities is more influential on their behaviour than the actual safety (Klobucar and Fricker, 2007).

A concept related to actual and perceived safety is *risk homeostasis* (Wilde, 1998). Risk homeostasis is about the fact that humans always look for the limit of acceptable perceived risks. If something is perceived as safe, humans are taking more risks compared to when something is perceived as risky (Wilde, 1998). Thus, perceived safety influences actual safety. This principle can also be applied to cycling in particular. If cycling is perceived as safe, people are likely to take more risks (e.g. higher speeds, taking fast turns). If cycling is perceived as unsafe, people are likely to be more careful (e.g. avoid particular routes, cycle slowly).

When keeping risk homeostasis in mind, a cycling infrastructure can be designed accordingly. One of concepts addressing safety for road users is *sustainable safety* ('*duurzaam veilig*') as described by SWOV (2018). Sustainable safety aims to improve the traffic safety in the Netherlands in general by putting humans at the centre. The main principles of sustainable safety are the demands, competences, limitations, and vulnerability of humans (SWOV, 2018). It requires infrastructures to be designed in such a way that severe traffic accidents are prevented, and that if an accident occurs, the consequences are minimal (SWOV, 2018[a]). A concept that reduces risky behaviour is shared space, where perceived unsafety is used to make people behave more careful (Hamilton-Baillie, 2008). Of course, the applicability of this concept is dependent on local circumstances.

2.6.2. E-bikes and safety

When talking about e-bikes and safety, there are quite some issues. First of all, the e-bike can reach higher speeds and is heavier than a regular bicycle. Namely, an e-bike has an average speed of 23 km/h, while a regular bicycle reaches only 14 km/h (Dozza et al., 2013). This can increase the chance of accidents as well. This statement is substantiated in fatalities and injuries statistics from the study of Weber et al (2014), who found that half of the bicycle accidents in a rural environment are unilateral accidents. Thus: it seems that accidents in a rural environment are more related to infrastructure than in an urban environment. Of course, this does not mean that bilateral accidents do not occur. The interaction between cyclists themselves and other road users is logically just as important to consider. This is because both the e-bikers and regular cyclists need to adapt to the higher speeds of e-bikes (Dozza et al., 2013). For example, estimating if you can cross an intersection becomes different when cyclists coming from left or right have higher speeds than people are used to.

Lastly, It is evident from the study of Bai et al. (2013) that e-bikers are more likely to be risky behaving that regular cyclists, especially at intersections (e.g. ignorance of red lights). the presence of e-bikes increases the number of incidents at signalised intersections (Bai et al., 2013). Probably this risky behaviour has to do with the risk homeostasis (Wilde, 1998). E-bikers get used to their speeds and turn into similar behaviour as they do on a regular bicycle. Therefore, the concept of sustainable safety (SWOV, 2018) might be helpful in developing a bicycle infrastructure that addresses the different behaviour from e-bikers.

2.6.3. What makes a road safe?

Keeping in mind the information about safety, perceived safety, and e-bikers' behaviour, there are several suggestions to make the physical infrastructure be safe and perceived as safe. Dufour (2010) for example has three suggestions for cycling in general (in both urban and rural environments). The first suggestion is about how to best mix different types of traffic. It can be questioned whether mixing traffic in a rural environment will be feasible, because of the long travel distances of many motorised vehicles. However, if mixing traffic, it is suggested to reduce the traffic intensities and lower the speeds below 30 km/h in order to make it safe for cyclists (Dufour, 2010). For example, low density residential areas could be a feasible location for mixing motorised traffic with cyclists, having a maximum speed of 30 km/h. For actual safety, the reduction of speed indeed helps in reducing the chance of accidents between motorists and cyclists, especially at intersections (Bellefleur and Gagnon, 2012; Petritsch et al., 2006). This suggestion can be related to the risk homeostasis as presented by Wilde (1998). When mixing different types of traffic, all road users should be more aware of the other road users, which makes them feel more at risk. This can, according to Wilde (1998) lead to less risky behaviour.

The second suggestion of Dufour (2010) would be more useful in a rural environment. It states that, when dealing with big speed and mass differences, cyclists should be separated in space and time. This decreases the number of potentially dangerous encounters. As an example, Petritsch et al. (2006) specifically suggest to minimize the number of parking spaces at the other side of cycle paths, since this increases the number of possibly dangerous encounters. It is proven that roads are perceived as safer when no parking spaces are present next to the road. This effect is even stronger in rural areas, possibly because it is less likely that cyclists expect parked cars in a rural environment (Stinson and Bhat, 2003). In case such an encounter is impossible to avoid (i.e. intersections), Dufour (2010) suggests as a third point that the road users should be made aware of the danger by designing the infrastructure in such a way that they will adjust their behaviour (Dufour, 2010). Again, risk homeostasis can be found here, since the infrastructure enhances less risk-taking behaviour (Wilde, 1998).

Of course, the suggestions by Dufour (2010) interlink with each other. For example, reducing the speed of motorised vehicles can help in making them aware of the possible dangers of encountering cyclists. Also other infrastructural design elements influence cycling safety and have linkages with the three suggestions by Dufour (2010). A hard shoulder at the side is perceived to be safe by commuters on a bicycle (Noland and Kunreuther, 1995), although this is not found for pavements in particular (Rodríguez and Joo, 2004). It is clear from literature that sudden endings of the cycling infrastructure is perceived as fairly unsafe (Stinson and Bhat, 2005).

2.7. Attractiveness

Attractive surroundings are a strong determinant for travellers to cycle (Gatersleben and Uzzel, 2007). This is just one statement about the importance of attractiveness for cycling. While about the importance there is consensus, the definition of attractiveness leaves more room for interpretation and subjectivity, both among scientist and cyclists. For example, attractive can be defined as a cycling infrastructure that is designed and blended with the surroundings in such a way that people are attracted by it to cycle (CROW, 2006). Still, this is mostly related to the (different) perceptions of the users (Dufour, 2010). It can therefore not be labelled as one objective standpoint, but rather as a combination of different perspectives. According to CROW (2006), it can even be the case that some aspects have a positive effect on one person's cycling behaviour, while it has a negative influence on the behaviour of someone else. This does not mean that attractiveness should be ignored. Dufour (2010) argues that these - sometimes varying - perceptions should get significant attention in bicycle planning when investigating why travellers do use or do not use the cycling infrastructure. Therefore the following sections elaborate on what factors do and do not enhance the attractiveness of cycling.

2.7.1. Cycle path location

According to Bohle (2000), minor roads (i.e. with a low traffic intensity) are generally perceived as more attractive than major roads. This is especially true for roads with mostly motorised traffic. Cycle paths located next to busy car roads do therefore not imply a high attractiveness. Even if roads have low volumes of car traffic, cyclists prefer to be separated from these roads. Thus, separate cycle lanes are perceived as more attractive than on-street cycle lanes (Bohle, 2000). Section 2.7.2 - *Perception of comfort* gives a more extensive elaboration on using either separate cycle paths or on-street cycle lanes, since this is also strongly linked with the perceived comfort of cycling. The preference of cyclists to cycle on separate cycle paths far away from motorised traffic has probably to do with the noise nuisance and air pollution that is caused by these vehicles. Cyclists namely prefer to cycle in a quiet environment and to breath clean air (Hagemeister et al., 2005). If a separate cycle path away from major roads is not possible for some reason, a considerable alternative is minimising the noise nuisance by for example installing sound barriers.

2.7.2. The natural landscape

Attractiveness is, besides the localisation of the cycle paths and roads themselves, about the surrounding landscape, and social safety (Dufour, 2010). When looking more closely at the environment of a cycling infrastructure, it becomes clear that the surrounding landscape is highly important regarding the choice whether to cycle at all, and how often. Just to mention, an attractive surrounding landscape that is spatially embedded well is more important for cyclists than for car drivers (Heinen et al., 2010). The surroundings are related to the 'experience' of cycling, which entails the psychological factors around cycling. This 'intangible' term makes 'attractiveness' difficult to concretise, as the experience of cycling is determined by one's own opinion and image (CROW, 2006).

Although it is subjective, still, there are many indicators of what is generally perceived as attractive and non-attractive, which can be useful of policy-making. A landscape that is open and monotonous is experienced negatively: it makes the cycle trip rather boring, particularly due to the long travel distance. An open landscape in general is not perceived as boring. On the contrary, even. Having a far view is valued positively (Mossel, 2018). Thus, there should be some kind of variety in the landscape to make it attractive for cyclists. An open landscape is not avoided by e-bikers in particular, since they are less sensitive to strong winds (see section 2.8.4 - *Weather and climate*).

Besides an open landscape, attractiveness increases when the cycle path is located in an area with greenery. However, this conflicts with social safety (see below). Women and children in particular prefer other routes that are perceived as socially safer (Bohle, 2000). Thus, it is important to make sure that a cycling infrastructure should offer different routes that have different characteristics.

2.7.3. Social safety

A route can be perceived as unattractive when social safety levels are low. Just as for 'safety' in general, also social safety exists in two kinds: actual social safety and perceived social safety. Both types are important determinants for the use of the cycling infrastructure (Dufour, 2010). An example regarding insufficient social safety can be fear. People can fear specific dangerous spots, such as tunnels or other poorly lit areas, and avoid them (Vis, 1994). Especially during periods without daylight these kind of spots are avoided. Indeed, during evening and night, social safety becomes more important. As mentioned before, women and children prefer to use more open and enlightened routes (Bohle, 2000). Social safety has also much to do with the view ahead. The verges around a cycle path should be mostly open and have no blocking elements, such as plants. The same holds for the twisted perspective: a cycle path should be visible from other places to enhance the feeling of social safety (Hagemeister et al., 2005).

2.8. Comfort

A cycling infrastructure is comfortable when it enables a quick and comfortable flow of cyclists (CROW, 2006). Quick and comfortable should be interpreted in a broad way: any nuisance and delay, from origin to destination, should be minimised. This can for example be caused by traffic lights, stopping signs, or

crossings where cyclists have to give way to other road users. These situations ask for a relatively high effort from cyclists (Fajans and Curry, 2001). Rietveld and Daniel (2004) state that how often cyclists have to stop and other barriers in road use are important determinants of whether a route is comfortable. Cyclists cycle around traffic lights and other stops to prevent them from stopping and accelerating too often (Stinson and Bhat, 2003). Hence, according to Rietveld and Daniel (2004), people tend to use a bicycle less in areas with many traffic lights and stopping signs. A cycle trip with an irregular effort makes cycling less pleasant (and less cohesive, see section 2.3 - *Cohesion*). The same holds for an uneven road, hills, and hindrance from bad weather and other traffic (CROW, 2006).

The quality of cycle paths or roads is an important factor, which is experienced as annoying when in a bad state (Mossel, 2018). This effect is even stronger for e-bikers. According to the CROW knowledge institute (2006), these uncomfortable factors are strongly related to the experience of cycling, and the perceived unsafety. Discomfort can lead to more stress, especially among the unexperienced cyclists (young people) and the less mobile cyclists (the elderly). More stress could induce faults, and therefore increase unsafety (CROW, 2006). Thus, while safety and comfort are ranked differently when it comes to importance (safety is ranked first and comfort is ranked fourth), this does not mean that comfort should be seen as a less important and independent principle. Improving comfort can lead to an enhanced safety level.

2.8.1. Facilities at destination

Besides comfort while cycling, also the presence of cycling facilities at the destination (e.g. bicycle racks at work location) are among the determinants to cycle (Heinen et al., 2010). Many authors found that, especially for e-biking commuters, bicycle parking facilities (lockers, enclosures, racks, charging facilities) at their destination are essential (E.g. Jones et al., 2016; Popovich et al., 2014; Hunt and Abraham, 2007). This also holds for the when the destination is an intermediate stop, such as a public transport stop (Taylor and Mahmassani, 1996). The study of Pucher (2001), who compared cycling infrastructures of several countries, adds to that that countries with more cycle facilities have better safety levels. Thus again, cycling safety is fed by a high comfort level.

The emphasis on bicycle facilities differs regarding the price of people's bicycle: someone owning an expensive bicycle considers bicycle locking facilities as more important than someone with a relatively cheap bicycle (Hunt and Abraham, 2007). Keeping in mind that there is an upward trend in more expensive bicycles (e-bikes, speed pedelecs), locking facilities should be given more attention nowadays and in the future. Another important determinant of present bicycle facilities at work is the cycle culture at work (Heinen et al., 2010). Thus, employers can play a significant role in improving the cycling infrastructure.

All in all, a cycling infrastructure which is lacking in these elements causes the cyclist to do more effort, which makes the cycle trip less comfortable.

2.8.2. Perception of comfort

The cyclist's perception of comfort was investigated by Li et al. (2012), who looked at the relationship with the physical environment. They mainly found that the following six factors are important determinants: the width of the cycle path, the slope, the presence of bus stops, physical separation from pedestrians, the surrounding land-use, and the bicycle flow rate (Li et al., 2012). However, there is a difference in perception when distinguishing between cycling on a separate cycle path and cycling on street lanes. For separate cycle paths, the geometry of the cycle path (length, width, curbs) and the surrounding conditions are the most influential factors for the perception of comfort (Li et al., 2012). Thus, both the cycling infrastructure itself and its immediate vicinity are important for the perception of comfort. This is different for on-street cycle lanes. Here, the space available for cyclists and traffic conditions are most important (Li et al., 2012). Another striking fact is the difference in preferences between these two types of cycle paths when it comes to perceived comfort. On separated cycle paths, cyclists prefer to have as few as possible other cyclists sharing the cycle path, while for on-street cycle lanes this is different: cyclists now prefer to have a vast volume of other cyclists to feel more comfortable (Li et al., 2012). A potential clarification for this could be related to the perceived safety of cyclists. Cyclists feel more insecure when surrounded by motorised traffic,

while in case of a cyclists-dominated road, motorised vehicles have to adapt more to the presence of cyclists. Although Dufour (2010) suggests to separate cyclists as much as possible from motorised traffic, one can imagine instances where on-street cycle lanes are a feasible option, albeit often in an urban environment. Namely, narrow roads or streets do often not have space to have separate cycle paths. If this road has a significant flow of cyclists (i.e. dominant with respect to motorised vehicles), it is, according to Li et al. (2012), a good option to incorporate on-street cycle lanes.

2.8.3. Slope and hilliness

As mentioned in the previous section, slope is considered as an important factor regarding cycling comfort (Li et al., 2012). Still, author's conclusions are divided whether slope has a negative influence on comfort. For example, Rietveld and Daniel (2004) and Rodríguez and Joo (2004) found a significant negative effect of steep slopes on cycling comfort. On the contrary, Stinson and Bhat (2005) did not find this effect and argue that cycling downhill functions as a compensation for cycling uphill, and therefore the negative effect of cycling uphill diminishes. They add that the preference of flat, hilly, or mountainous infrastructures differs between experienced and unexperienced cyclists. Experienced cyclists favour hilly infrastructures, while unexperienced cyclists favour flat infrastructures (Stinson and Bhat). Of course, it can be questioned whether factors such as hilliness and slope have a significant effect in the Netherlands, of which the greatest part is flatland. Furthermore, the e-bike has the advantage that it is easier to cycle over small hills (Mossel, 2018), which reduces the effect of slope and hilliness even more. For cycling infrastructure design policies, only bridges, tunnels, and other infrastructural works that involve steep slopes could be taken into account.

2.8.4. Weather and climate

Although not physically part of the cycling infrastructure, infrastructural design measures could possibly help to reduce the negative effects of weather and climate. According to Rietveld et al. (2012), the cyclist is most sensitive to weather conditions, compared to other travellers. For example, high temperatures lead to an increase of 30% in bicycle trips (Rietveld et al., 2012). Rainfall is the most named cause for not choosing the bicycle as a transport mode (Harms, 2008). The effect of a strong wind differs between regular cyclists and e-bikers: e-bikers experience a strong wind as less uncomfortable than regular cyclists, due to the electrical assistance. It should be noted that the effect of weather conditions is smaller for commuters, since they often have no other choice, and therefore always choose the bicycle no matter what the weather looks like at that moment (Rietveld et al., 2012). Heinen et al. (2010) still argues that it is valuable to perform further research on measures and facilities that might lessen the effect of bad weather conditions. CROW (2006) comes with small shelters as a suggestion. These shelters could then be placed on logical spots where cyclists usually have to wait, for example near bridges, ferries, public transport stops (CROW, 2006). Logically, social safety should not deteriorate as a consequence, so the shelters should be open and visible.

2.9. Ranking of the five principles

The five principles that are described in the previous sections can be ranked according to importance from the commuter's perspective. At all times, safety should be priority number one, no matter what the purpose of the cycling network is. This is the number one according to the CROW framework (CROW, 2006), but also Allen-Munley and Daniel (2006) state that cyclists consistently put safety as the absolute priority when selecting bicycle routes. When cycling is (perceived as) unsafe, other modes are easily chosen. The commuter prioritises the other principles as follows: directness is ranked second, cohesion is ranked third, comfort is ranked fourth and attractiveness is ranked fifth. It should be noted that this ranking is based on the view from solely the commuters, so recreational cyclists for example are not taken into account (CROW, 2006). It is interesting to see whether this ranking is also found back in practice.

2.10. Conceptual model: the cycling infrastructure guideline

This section looks back at the three principles safety, attractiveness, and comfort briefly. This is summarised in a conceptual model, shown in figure 2.

As written in section 2.6, safety is divided into two types, actual and perceived (Heinen et al., 2010; Cho et al., 2009). To account for the effects of risk homeostasis, the cycling infrastructure can potentially be designed in such a way that risky behaviour is minimised, for example by shared space (Hamilton-Baillie, 2008). Further, mixing motorised traffic and cyclists should only be done on roads with a 30 km/h speed limit (Dufour, 2010; Bellefleur and Gagnon, 2012; Petritsch et al., 2006). With higher speed differences, cyclists and motorised traffic should be separated to have no dangerous encounters (Dufour, 2010). When avoiding such encounters is not possible, all road users should be made aware of the potential danger (Dufour, 2010). Lastly, the cycling infrastructure should not have sudden endings (Stinson and Bhat, 2005). The area-oriented approach (Heeres et al., 2012) can play an important role in enhancing safety. As mentioned in the safety section, safety has a lot to do with other traffic (e.g. motorised traffic). Therefore, it is important to take a broader perspective on cycle planning for improving cycling safety. Namely, it is not only concerned with the cycle path or lane itself, but with the relation of the cycle route to its surrounding traffic, and therefore its surrounding roads.

Section 2.7 explains that attractiveness is the most subjective part of cycling. Still, attractiveness should be considered explicitly, as it has many indicators for an attractive cycle route. These are: cycle paths should be a separate entity (Bohle, 2000), and if not possible, noise nuisance from major roads should be minimised. Secondly, an attractive cycle route is spatially embedded well, with omnifarious, green and open surroundings, ensuring a far view every now and then (Mossel, 2018; Bohle, 2000). Since social safety and green surroundings sometimes conflict, it is the challenge to develop a cycling infrastructure that offers a combination of green routes, and socially safe routes, where people have a choice. Most of the described elements under attractiveness do have to do something with the surroundings. The area-oriented approach (Heeres et al., 2012) as examined in section 2.3, can be advantageous in enhancing the attractiveness of the surrounding environment, and the integration of cycle paths with their environment. Therefore it is important to consider the use of an area-oriented approach in cycling infrastructure planning.

In section 2.8, it is written that comfort is about minimising any nuisance and delay from origin up and until destination (CROW, 2006). There should be no stops, no bumps, cycle paths and lanes should be wide enough, and it is valuable to consider measurements that lessen the effects of bad weather conditions, and to implement bicycle facilities at destinations (lockers and racks) (Li et al., 2013; Heinen et al., 2010; Mossel, 2018). Also for comfort an area-oriented approached as proposed by Heeres et al. (2012) is relevant to take into consideration. For example, having cycle paths or lanes that are wide enough requires planning that aims to integrate the cycle path or lane with its surroundings to make it fit.

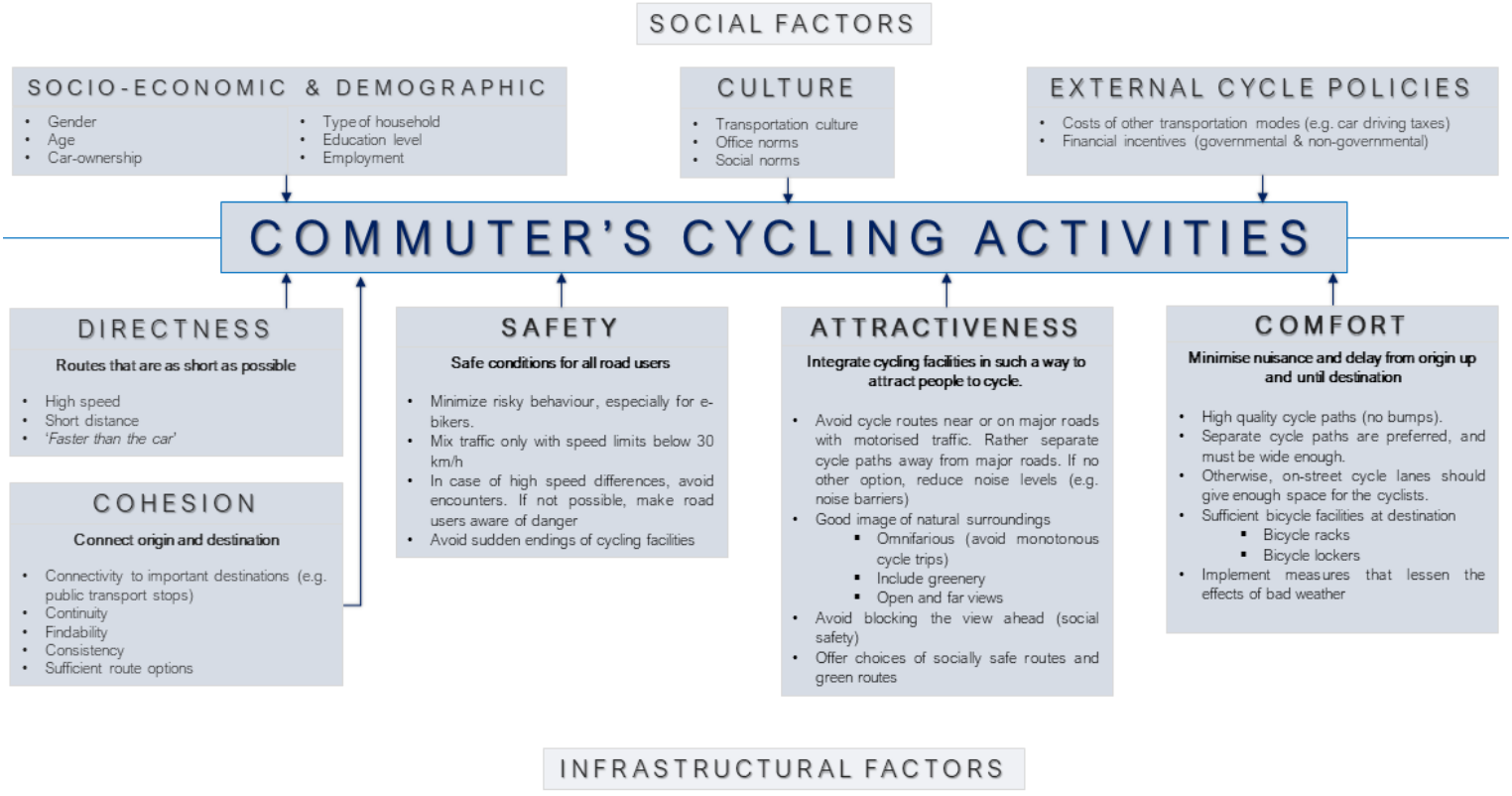

FIGURE 2: CONCEPTUAL MODEL OF HOW COMMUTER'S CYCLING ACTIVITIES ARE ENTAILED BY A BROAD RANGE OF FACTORS, HIGHLIGHTING SAFETY, ATTRACTIVENESS, AND COMFORT.

3. | Cycling infrastructure's planning process and its institutional setting

Before diving into the real practice of cycling infrastructure planning, it is important to take one step back and take notion of the common institutional setting and the steps of the planning process of cycling infrastructures, and fast cycle routes in particular. Therefore, this chapter examines several sources where such information can be found, both from the Dutch government and from practice.

Usually, cycle routes, and fast cycle routes in particular, cross different administrative boundaries. Therefore they involve several administrative bodies, i.e. municipalities and provinces. The municipalities have several different tasks, such as creating the spatial development strategy (*structuurvisie*) and creating and changing the zoning plan, as written in the Dutch spatial planning act. In a spatial development strategy, a municipality writes down the main issues of the spatial policy to be conducted by the municipality. The same is done in the spatial development strategy that is to be developed by the province, and for the one to be developed by the national government. All of them have different tasks on a different scale. The municipality and the province are important players when it comes to spatial planning, for example the development of cycle routes. The municipalities go one step further in spatial detail in their zoning plans. The zoning plans entail rules about what is allowed on particular plots of land, and what is not. They check whether it is feasible to locate the cycle route in that particular location, and determine what the necessary tasks are to continue the project. For example, for a cycle route through a natural area, a construction permit is required, which has several prerequisites. Then, they set up the new zoning plan for the cycle routes locations where needed, and develop municipal policies, for example about cycling infrastructures. It is also possible that the municipal council develops a spatial development strategy together with several other municipalities. (Overheid.nl, 2019; Gemeente Valkenswaard, 2014).

Besides the involvement in the project development and implementation, there is also involvement in terms of financing the project. Financing is usually done from different parties, including the municipalities that are crossed by the cycle route. In addition to that, the national government (Ministry of Infrastructure and Water Management) has a program that stimulates cycling in several ways, including improvements on safety, attractiveness, and comfort (Tour de Force, 2016). Other involved parties include water boards, regional bodies (e.g. 'regio Drechtsteden' and 'RegioTwente'), Rijkswaterstaat, and advisory companies fulfilling the technical tasks. The involvement of water bodies depends, logically, on the context of the project. A water board is involved only when needed for specific parts of the project, and not entirely throughout the process (De Jong and Smink, 2010).

There can be made a general overview of the time planning used in (cycling) infrastructure planning. According to several documents about specific cycling infrastructures (see below), the following sequence can be presented: The project generally starts with a preparatory phase, which is followed by the exploratory phase. In the exploratory phase, several options are explored and involvement processes usually start around here. This phase is followed by a plan development phase, which is afterwards executed in the fourth and last phase: realisation (and monitoring is started) (Goudappel Coffeng, 2017; Provincie Groningen & Grontmij, 2013).

here are several procedures necessary for the implementation of a new cycle route. Each of them is focused on a specific aspect of influence, thereby reflecting the impact of the cycle route on the environment. These include:

- Act on air quality
- Environmental Impact Assessment
- Soil and groundwater assessment
- External safety
- Archaeology
- Cultural history
- Flora and fauna
- Water
- Traffic

Besides these separate assessments, the entire plan is also assessed on two main themes: society and economy. In these two themes it is assessed whether the plan is feasible. In other words: the plan should be economically feasible (do the involved parties have enough financial resources?) and societally feasible (have all the societal interests been taken into account and have the potential impacted communities been informed timely?) (Gemeente Valkenswaard, 2014).

When combining chapter two and chapter three, one present it in a model as shown in figure 3 below.

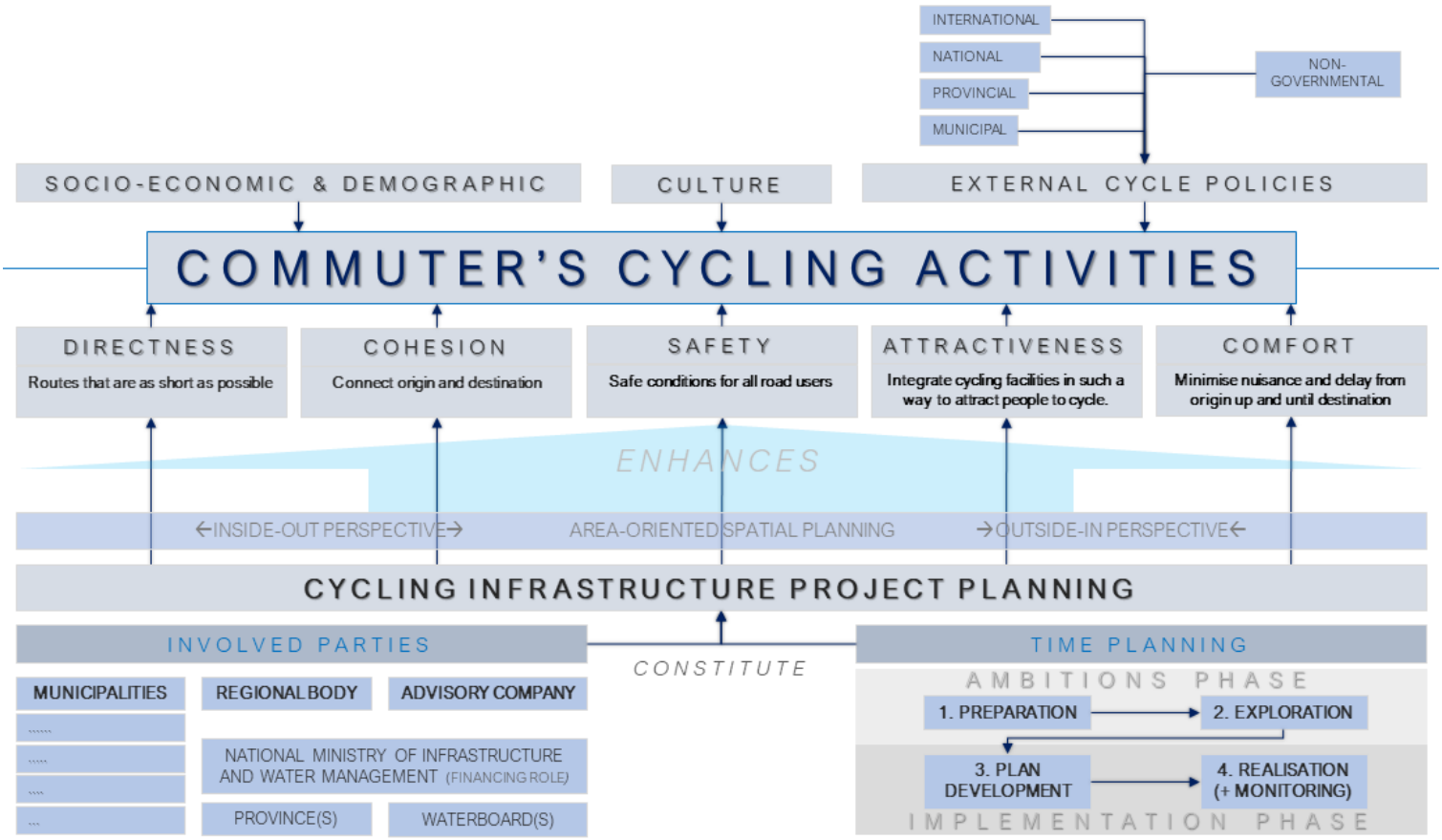

FIGURE 3: CONCEPTUAL MODEL OF THE FACTORS INFLUENCING COMMUTER'S CYCLING ACTIVITIES, HIGHLIGHTING THE PLANNING PROCESS LINKED TO IT. INFORMATION IS BASED ON SEVERAL SOURCES AS SHOWN IN THIS CHAPTER (E.G. OVERHEID.NL).

4. | Methodology

This chapter gives a detailed description of the methodologies that are used in this research. This research consists of two parts: document analyses and interviews. Five Dutch cases are examined (see section 4.1), and for each case a document analysis is performed (section 4.2), and one or more interviews are carried out (section 4.3). It is chosen to use two different research methods for the reason that research outputs are more valuable, reliable, and credible when having different sources of information and data collection, since the chance of biased information can be reduced (Bowen, 2009). This research aims to reveal underlying reasons behind particular choices made in bicycle planning. One can think of a consideration between directness and attractiveness and why one of those two sides is chosen in that particular situation. An interview is in this case the perfect instrument to reveal those underlying reasonings. Other methods, such as surveys, are not used since, logically, the type of information (qualitative, underlying reasoning) that is looked for cannot be obtained by using quantitative research methods.

4.1. Case selection

The cases for this research are selected based on certain criteria. First of all, the project should be a fast cycle route project, which aims to connect cities and towns on a long distance (>7,5 km) through, mainly, rural areas. Fast cycle routes are chosen specifically since they are a relatively new phenomenon and can therefore show the most recent planning practices of rural cycling. The cycle route should also be located in the Netherlands. To get enough useful information, there should be documents available that describe how the cycle path will be designed, and the cycle route should preferably be near, during, or after implementation. To obtain a general overview of the Netherlands, cases are sought over different geographical locations, and over different timescales within the past decade.

The cases that are selected are listed in table 1. Not all currently exploited fast cycle routes in the Netherlands are considered in this research, since not all their documents are publicly available, or had a lower quality. Each document is checked on beforehand on whether they contained sufficient and high-quality information about the planning process. In addition, according to Bowen (2009), it is better to give priority to a short list of high quality documents, than a long list containing some low quality documents, that do not contain sufficient information for this research purpose. Table 1 also shows the documents' names that are under investigation. The interviewees for each case are shown in section 4.3.

TABLE 1: OVERVIEW OF CASES

#	Cycle route	Connection between	Province	Document name	Author(s)	Year
1	Snelle fietsroute Apeldoorn - Epe	Apeldoorn ↔ Epe	Gelderland	*Snelle fietsroute Apeldoorn - Epe*	Goudappel Coffeng	2017
2	Doorfietsroute Groningen - Ten Boer	Groningen ↔ Ten Boer	Groningen	*Fietsroute plus Groningen - Ten Boer. Analyse, afweging en advies verkenningenfase*	Provincie Groningen & Grontmij	2013
3	Oude Spoorbaantracé	Eindhoven ↔ Valkenswaard	Brabant	*Bestemmingsplan Oude Spoorbaantracé*	Gemeente Valkenswaard	2014
4	RijnWaalpad	Arnhem ↔ Nijmegen	Gelderland	*Tracé - ontwerp RijnWaalpad*	Gemeenten Lingewaard & Overbetuwe	2010
5	Fietssnelweg F35	Nijverdal / Vriezenveen ↔ Enschede / Glanerbrug	Overijssel	*Masterplan Fietssnelweg F35*	Regio Twente Goudappel Coffeng	2014

FIGURE 4: MAP SHOWING THE FIVE CASES OF THIS RESEARCH

4.2. Document analysis

This section aims to answer sub question 1 *"How are safety, attractiveness, and comfort getting attention in Dutch bicycle plan decision documents in relation to directness and cohesion?"* This is investigated by having a close look at documents that describe and explain the implementation of *fast cycle routes*, or *cycle highways,* in the Netherlands. By studying such implementation documents, the documents are interpreted to reveal their meaning regarding a specific research topic (Bowen, 2009), which is in this case the implementation of safety, attractiveness, and comfort in that particular cycling infrastructure. The analysis process can consist of coding texts from documents into themes, just as done for interviews (Bowen, 2009). These themes would in this case be the five CROW principles directness, cohesion, safety, attractiveness, and comfort.

Implementation documents fall under *public records* in the categorisation of documents by O'Leary (2014). This research method is chosen because these documents can reveal what is actually done by provincial policy makers regarding safety, attractiveness, and comfort, especially compared to directness and cohesion. Second, documents are very accessible and reliable sources, making it manageable and practical in the process of data collection. Third, it is time- and cost-efficient, for example in comparison to own data collection. Compared to interviews, they are more stable, meaning that they do not change during the process, and thus can be consulted several times (Bowen, 2009). Lastly, background information can be obtained in preparation for the interviews as described in section 3.2.

To obtain the desired information from the document, *content analysis* (also referred to as *noting occurrences*) is an appropriate technique to discover certain concepts (O'Leary, 2014). To do this, Bowen (2009) comes with a three-step-approach, which is the following: (1) determine what concepts are being searched for (in the case of this research related to the five principles); (2) document and organise the frequency and amount of occurrences of those concepts; and (3) sort the information into what is related to the research questions (Bowen, 2009). In addition to that, a document is created that describes salient points from the document under investigation in a bullet point manner. This information is then used as background information as preparation for the interviews.

When performing a document analysis, some issues should be taken into account. First of all, the documents under consideration have different purposes than the purpose of this research. For example, they have a different target audience. According to O'Leary (2014) this may influence the information obtained from the document. For example, it can be the case that any details with spatial planning specific information is not included in order to make the document comprehensible for the general public. Another issue is that a document may not provide all necessary information required to answer the research question. E.g. a document may not mention anything about cycling safety, while in practice this is definitely part of the planning process. The interviews are therefore in this case a helpful tool to reveal possible undocumented elements.

4.2.1. Terms that entail safety, attractiveness, and comfort

This section provides information about the concepts that are being searched for, as written in the first step by Bowen (2009). The theoretical framework, sections 2.4, 2.5, 2.6, 2.7, and 2.8 to be specific, give the elements that fall under the five principles directness, cohesion, safety, attractiveness, and comfort. These are now translated into concepts that are to be searched for in implementation plans of fast cycle routes in the Netherlands. For all of these, logically, synonyms or terms that describe a similar concept are also counted. Besides the already stated concepts of safety, attractiveness, and comfort, also possible other interpretations of these principles must be written down, as intersubjectivity plays an important role here. Since Dutch documents are investigated, Dutch words are used. For each principle, word clouds are created and shown in tables 2, 3, 4, 5, and 6.

TABLE 2: TERMS THAT ENTAIL DIRECTNESS ('DIRECTHEID') IN RANDOM ORDER

Dutch	English
Directe verbinding	Direct connection
Gestrekte route	Straight route
Zo min mogelijk omrijden	As few detours as possible
Shortcut	Shortcut
Snel	Fast
Rechtstreeks	Direct
Gestrekte verbinding	Straight connection
Directe route	Direct route
Doorstroming	Continuous flow
Concurrent voor de auto	Competitive for the car
Infrastructuur voor hogere snelheden	Infrastructure for higher speeds
Zo recht mogelijke lijn	Straightest line possible

TABLE 3: TERMS THAT ENTAIL COHESION ('SAMENHANG') IN RANDOM ORDER

Dutch	English
Bundelfunctie	Bundle function
Verschillende opties	Different options
Aansluiting op andere plaatsen	Connected to other places
In samenhang met (H)OV en autonetwerk	In cohesion with public transport and car network
Aansluiting op fietsnetwerk	Connection to cycle network
Samenhang	Cohesion
Herkenbaarheid	Recognisability
Eenduidig	Unambiguous
Consistentie	Consistence
Aansluiting op fietsknooppunten	Connection to cycle nodes
Keuzevrijheid	Freedom of choice
Vindbaarheid	Findability

TABLE 4: TERMS THAT ENTAIL SAFETY ('VEILIGHEID') IN RANDOM ORDER

Dutch	English
Veilige route	Safe route
Verkeersveiligheid	Traffic safety
Geen combi met auto's	Not together with cars
Attentie bij kruispunten	Attention at intersections
Ongelijkvloers	Under- or overpass
Fietsstraat	Cycle street
Veilige (tussen)berm	Safe (intermediate) roadside
Veiligheid bij kruispunten	Safety near intersections
Geen ontmoeting met ander verkeer	No encounters with other traffic
Geen obstakels	No obstacles
Tunnel	Tunnel

TABLE 5: TERMS THAT ENTAIL ATTRACTIVENESS ('AANTREKKELIJKHEID') IN RANDOM ORDER

Dutch	English
Natuurwaarden	Natural values
Vergezichten	Good views
Geen overlast van geluid / stank	No nuisance from noise / odour
Ver van autoverkeer	Far away from car traffic
Landschappelijke inbedding	Landscape embedding
Karakteristieke beplanting	Typical plants
Sociale veiligheid	Social safety
Ruimtelijke inbedding	Spatial embedding
Voldoende doorzicht	Sufficient view ahead
Aantrekkelijke omgeving	Attractive surroundings
Voldoende afwisseling	Sufficient diversity
Groene omgeving	Green surroundings
Verlichting	Lighting
Keuze in routes	Choice in routes

TABLE 6: TERMS THAT ENTAIL COMFORT ('COMFORT') IN RANDOM ORDER

Dutch	English
Fietsparkeervoorzieningen	Bicycle parking facilities
Voorrang voor fietsers	Cyclists' priority
Brede fietspaden	Wide cycle paths
Korte wachttijd bij verkeerslicht	Short waiting time at traffic lights
Minimaal oponthoud	Minimal delay
Goede verharding	Good surface
Non-stop	Non-stop
Egale route	Smooth route
Gladde route	Smooth route
Comfort	Comfort
(geheel) autovrij / autoluw	(entirely) car-free / low-traffic
Bescherming tegen wind	Protection against wind
Comfortabele rit	Comfortable journey
Voldoende beschutting	Sufficient shelter
Schuilmogelijkheden	Shelter possibilities

In the next step, it is documented if and how often these principles are considered, by counting the number of occurrences. The step afterwards entails comparing these occurrences and different interpretations with theory.

4.2.2. Expected results

Under results, the information from the document analysis is presented in three ways. First, all occurrences of the concepts and terms that entail directness, cohesion, safety, attractiveness, and comfort are depicted for each document. This is done in a straightforward and quantitative manner, as suggested by Bowen (2009) in step 2. Then secondly, these results are presented in a story-wise manner for theoretical comparison. In other words: the occurrences of all interpretations and concepts of each of the five principles together are presented, and compared with the interpretations that are presented in the theoretical framework (Chapter 2), as suggested by step 3 in Bowen (2009). Third, the potential ranking of the five principles is presented, according to the number of occurrences of each principle. These three steps are performed for each document separately. Afterwards, all results are collected to form one whole.

4.3. Interviews

4.3.1. Why and how?

This section aims to answer sub question 2 - *"How are safety, attractiveness, and comfort approached and implemented in Dutch bicycle planning practice?"* and sub question 3 - *"How do the planners deal with potential prioritisation dynamics throughout the planning process?"* and it describes the process of gathering this information through interviews. The type of interviews are semi-structured interviews, which allow for both structure and flexibility (Dunn, 2005). This is beneficial for this research since the interviews will need to obtain specific information about how bicycle route planning is approached, while there are some contextual differences between bicycle planning projects that require flexibility. Semi-structured interviews are therefore a good 'in-between' to address both these aspects.

The selection of interviewees is based on experience and involvement in a certain fast cycle route project in the Netherlands that is currently relatively far in the process or (nearly) completed. It must be made clear that this selection is not random, which is also not the aim of the interview as a research method (see Valentine, 2005). The interviewees are found and approached in various ways. Documents that are used in the document analysis are a useful source, where sometimes names of project managers are listed. Otherwise, the interviewees are approached by contacting a general e-mail address or phone number of an involved municipality or province. This then leads to the right person(s). All interviewees are listed in table 7.

TABLE 7: INTERVIEWEES, DATE, TIME, AND LOCATION

#	Interviewee	Role	Date	Location	Case
1	Rico Andriesse	Project manager (Goudappel Coffeng)	10-05-2019	Apeldoorn city hall, Apeldoorn	*Snelle fietsroute Apeldoorn - Epe*
2	Roland Hendriksen	Project manager (fietsruggengraat Cleantech Regio)			
3	Susan Martens	Apeldoorn municipality			
4	Greet Luurtsema	Project manager (Groningen province)	13-05-2019	Groningen provincial hall, Groningen	*Doorfietsroute Groningen - Ten Boer*
5	Albert Burggraaf	Project manager (Waalre municipality)	17-05-2019	Waalre city hall, Waalre	*Oude Spoorbaantracé Eindhoven - Valkenswaard*
6	Hans Oostelbos	Traffic policy officer (Valkenswaard municipality)			
7	Martijn te Lintelo	Mobility advisor at Arnhem municipality	22-05-2019	Arnhem city office, Arnhem	*RijnWaalpad Arnhem - Nijmegen*
8	Wim van der Wijk	Traffic engineer at RoyalHaskoningDHV			
9	Marjoline van der Haar	Project manager at RegioTwente	24-05-2019	RegioTwente office, Enschede	*Fietssnelweg F35 Twente*
10	Richard ter Avest	Advisor at Goudappel Coffeng			
11	Kees Lems	Traffic expert at Enschede municipality			

The interviews are subdivided into themes (or sections). The first section is created to introduce the thesis subject, and the cycle project itself, and obtain some more information about the project. The questions are generally easy to answer in order to let the participant feel comfortable. The second section entails obtaining information about what concepts or elements planners consider as important when implementing a fast cycle route. The last two sections address the dynamics of the interpretation of safety, attractiveness, and comfort, and the area-orientation of the planning process throughout the entire project. First, questions are asked about the ambitions at the start of the project, after which these ambitions are compared with the reality during and after implementation. All interview questions can be found in appendix A1 (English) and A2 (Dutch).

4.3.2. Transcription and analysis process

The interviews are audio-recorded. This audio record is used to transcript the entire interview, except from introductory parts and other irrelevant fragments. After transcription, the quotes, sentences, and words that show information relevant to the three research questions are highlighted in the transcript. These highlighted texts are then paraphrased into separate bullet point-structured text, subdivided into groups that show information about the same 'theme' (or 'codes'). For an example of this process, see figure 4. These themes are 'prioritisation and definition of principles', 'ambitions of the project', 'implementation of the project', and 'the use of area-oriented approaches and process dynamics'. After this, a summary is written based on the paraphrased texts.

FIGURE 5: EXAMPLE OF HOW AN INTERVIEW IS TRANSCRIBED, AND HOW THIS CODED INFORMATION IS GATHERED UNDER A THEME.

Later on, conclusions can be drawn from how safety, attractiveness, and comfort are interpreted and implemented in practical reality. Furthermore, as several questions are aimed to obtain information about the use of area-oriented practices and about potential dynamics within the prioritisation of the five principles and how these are addressed, conclusions can be drawn on these aspects. The results of these aspects are, together with the document analyses results, presented in the next chapter.

5. | Results

This chapter will describe the results from the document analyses and the interviews. The chapter is subdivided into the five cases that are examined in this research: *Snelle fietsroute* Apeldoorn - Epe, *Doorfietsroute* Groningen - Ten Boer, *Oude Spoorbaantracé* Valkenswaard - Eindhoven, *RijnWaalpad* Arnhem - Nijmegen, and *Fietssnelweg F35* Twente. All interview recordings and transcripts are available for request from the researcher.

5.1. Snelle fietsroute Apeldoorn - Epe

Route: Apeldoorn - Epe (see figure 6)
Province: Gelderland
Municipalities: Apeldoorn; Epe.
Current status: Not yet implemented, design process has started (implementation knowledge obtained from Apeldoorn - Deventer, a similar route nearby).

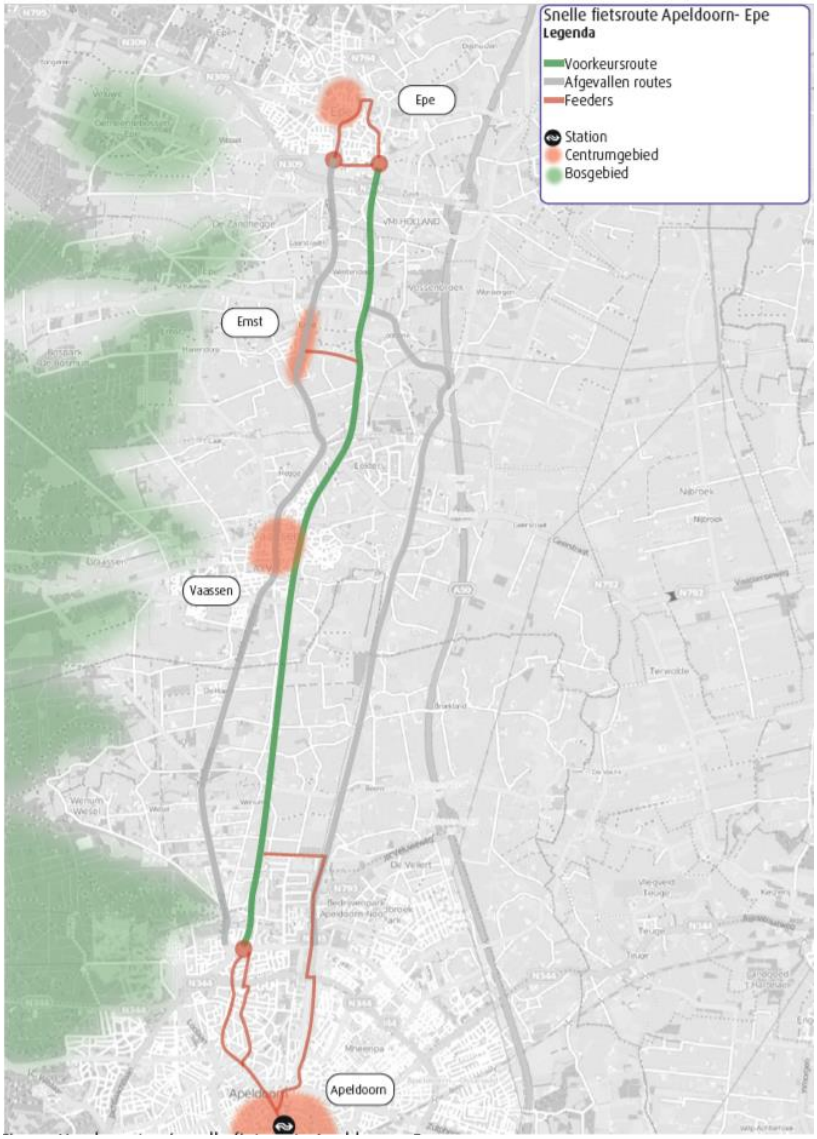

FIGURE 6: APELDOORN - EPE ROUTE (OBTAINED FROM GOUDAPPEL COFFENG DOCUMENT, 2017)

5.1.1. Document analysis

The document analysis for this case is done for the document "Snelle fietsroute Apeldoorn - Epe - Potentieanalyse, routekeuze en schetsontwerp" by *Goudappel Coffeng* from 2017. In appendix B1 the raw results from the document analysis are presented.

It can be observed that, in this document, all five principles receive attention, albeit not evenly spread. Cohesion for example has a significant lower number of occurrences than the other four principles. For example, there is no attention given to enhancing a cycle network where as many possible locations are reachable, by the creation of the cycle route. Attractiveness is the principle that receives most attention in this document. An important caveat here is that the only the term ´attractive´ or ´attractive cycle route´ accounts for quite a big share, where no extra definition is given. The same holds for safety and directness. This does therefore say nothing about the interpretation of these principles. However, there is a clear list of what, according to them, are the measures that entail the five principles, which are inspired by the CROW handbook for fast cycle routes, but includes additions from the province of Gelderland. For cohesion, they state that the signage of the cycle route is important. Directness entails that detours should be kept below 10% of the route as the crow flies, there should be no steep slopes, cyclists should have priority almost everywhere, especially at property access roads, and the waiting time at traffic lights should be below 15 seconds. Safety is here interpreted as the physical design of the cycle path, including its turns (which should not be too sharp), its width (minimal 4m), and obstacles (which should be avoided). Also, there is a requirement for maximum speeds of 30 km/h when sharing the road with cars. Comfort is about a sufficient width of the cycle path, priority for cyclists, and a car free route. Lastly, attractiveness is according to them enhanced by lighting that fits the environment, enough attention for the spatial and landscape embedding, and tunnels should be wide and have a sufficient view ahead for social safety.

Safety receives less attention in this document, although it should be noted that almost the entire cycle route consist of a separate cycle path already, making safety currently less relevant (although there are still important crossings, etc.). Lastly, there is no attention given to measures to lessen the effects of rain and wind, and to cycling facilities at destinations.

5.1.2. Interview 1, 2, & 3

This section summarises the plain information obtained from the interviews about the cycle route between Apeldoorn and Epe. The interviewees are Roland Hendriksen (project manager at *fietsruggengraat Cleantech Regio*), Rico Andriesse (project manager at *Goudappel Coffeng*) and Susan Martens (gemeente Apeldoorn). An extensive summary can be found in appendix A5.

The interviewees state that quick and safe are the most important principles. There should be safe framework conditions, which entail optimal priority for cyclists, crossing safely, and safe use. There is often some friction between the width and spatial embedding, where the question is whether to stick to guidelines or give value to a good spatial embedding. It is important to continuously take all five principles into account.

The first motive for starting this project is sustainability and the traffic safety related to the raise of the e-bike. Quite soon after, comfort becomes important as well, where questions about the quality of the cycle path come to the fore. Finally, also attractiveness and directness come forward.

When asking about the planning process, the interviewees stated that the process of involving local stakeholders was initiated relatively early, compared to other routes, although they did not involve individual local residents living on the route itself. They did involve specific interest groups: village councils, neighbourhood councils, *Veilig Verkeer Nederland* (Dutch traffic safety organisation), and the *Fietsersbond* (cyclists union). A lessons from this is that it would be better to start involvement a bit later, in order to prevent unnecessary rumours. The involvement of individuals was done at a later stage. A successful element of the involvement is the fact that the people concerned with the area's landscape (*landscapers*) became at some point enthusiastic about the cycle route because it functions as a 'flywheel' in the development of the landscape, i.e. the cycle route can bring the old diversity and quality of the landscape back. Therefore the landscapers and other disciplines see the added value of the cycle route. Still, there are other parties that do not see the added value of the cycle route.

Regarding the definition of safety, attractiveness, and comfort, there is a difference in concreteness between the principles. Since safety has clear requirements, these are known relatively early in the process. On the

contrary, attractiveness is much more vague and therefore hard to 'put into numbers' or make it concrete. Therefore, attractiveness is addressed at a later stage than safety. Comfort is in between those, albeit much more to the concrete side than to the vague side. Although this vagueness has an impact on the process, it is important to say that it is tried to stick for 100% to the requirements of a fast cycle route as long as possible. When you are making concessions in the first phases of the process, it is likely that you will not reach the level that you aim for in the end. Because of this, the decision-makers of this project decided to make possible concessions only after the preliminary design phase. This requires some political guts.

5.2. Doorfietsroute Groningen - Ten Boer

Route: Groningen - Ten Boer (see figure 7)
Province: Groningen
Municipalities: Groningen; Ten Boer
Current status: Completed (2018)

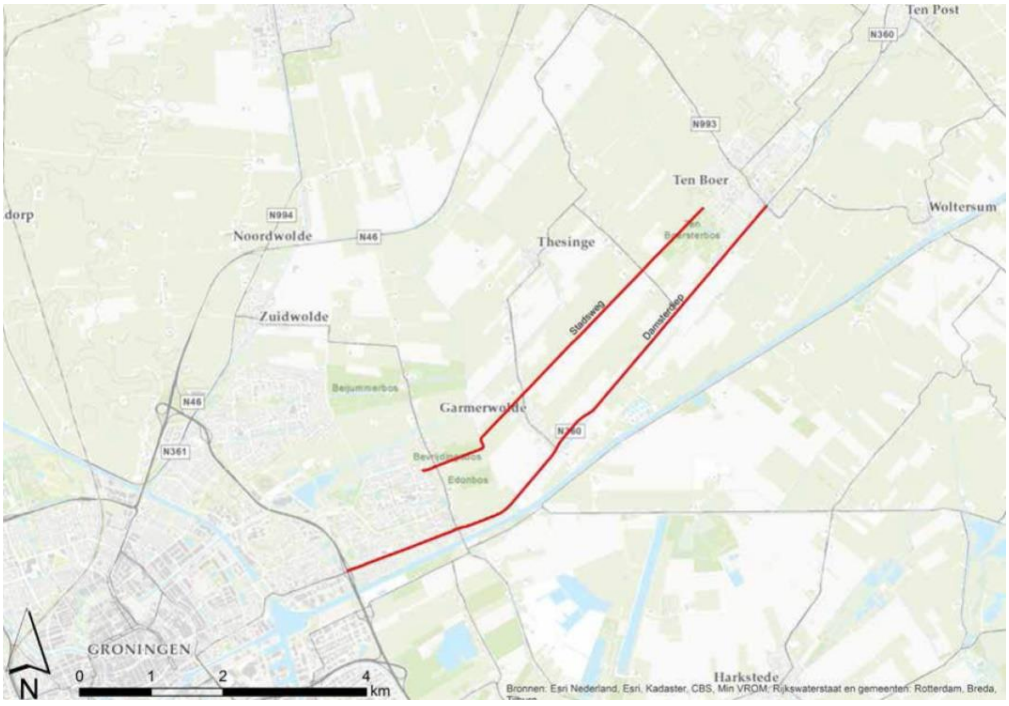

FIGURE 7: GRONINGEN - TEN BOER ROUTE, THE *STADSWEG* SECTION IS THE CURRENT *DOORFIETSROUTE* (OBTAINED FROM PROVINCE OF GRONINGEN DOCUMENT, 2013)

5.2.1. Document analysis

The document analysis for this case is done for the document "*Fietsroute Plus Groningen - Ten Boer - Analyse, afweging en advies verkenningenfase"* by Provincie Groningen and Grontmij from 2013. In appendix B2 the raw results from the document analysis are presented.

When observing the document, it is striking that the number of observations of traffic safety is relatively high compared to other terms. Another striking thing is that the focus on all five CROW principles is evenly spread over the document, with only some more attention given to attractiveness and comfort. Terms that fall under cohesion do not fall behind this time. Especially recognisability and findability appear relatively often. Also the connection to the broader cycle network gets quite some attention. The attractiveness concept receives most attention in this document, although no words are spent on omnifariousness and sufficient views ahead. The terms 'attractive route', 'attractiveness', and 'spatial embedding' are mentioned often. For attractiveness, however, it is stated that it is built up of the other four principles, instead of being a principle on its own. In addition, it is more personal, and non-distinctive. For comfort, the word comfort itself is often the most, followed by 'wide cycle paths'. However, the requirement is not set at 4 meters (as advised by

CROW), but at 3 or 3,5 meters, depending on the number of expected cyclists. Also the notion of enough protection against wind is mentioned relatively often, just as shelter possibilities. Directness in this document is mostly entailed by terms such as straight and direct lines, and fast. In addition, the authors put 'minimise crossings', 'cyclists' priority', and 'minimal waiting time at traffic lights' under directness.

Other relevant information from the document is that gaining support from the surrounding stakeholders receives special attention. Although the level of support is not leading in the choice for the alternative, it is stated that the risk of a lack of support should be minimised by involving stakeholders intensively and having a well-developed communication strategy, at an early point in time.

5.2.2. Interview 4

This section summarises the plain information obtained from the interview about the cycle route between Groningen and Ten Boer. The interviewee is the project manager of this cycle route, Greet Luursema on behalf of the province of Groningen. An extensive summary can be found in appendix A6.

Regarding the definition of principles, attractiveness is defined as a combination of directness, cohesion, safety, and comfort. Actually, it is a definition issue. When asking the cyclists between Groningen and Ten Boer themselves, they state that the route along the Stadsweg is attractive because of its traffic safety, comfort, the ability to cycle continuously, and 'cycling nicely through the countryside'. This is related to spatial embedding, which is, according to the interviewee, important but not leading.

The main and initial goals of the cycle routes is to attract more cyclists, less people in the car, and better traffic safety in general (not related to the e-bike specifically). The ambition was to have a cycle path of 3,5 meters wide, but it is 3 meters now. This was already clear during the planning process, because local residents and the province's own experts for landscape aesthetics, advised to keep it to 3 meters. This was done only for aesthetical reasons. When 3,5 meters was applied, a complete different design of the dike was needed, which would have been bad from an aesthetical perspective. Shelter facilities were among the ambitions, but still need to be realised (while the route itself is completed). Not everyone is in favour of these since they can turn into hanging-out spots. Another drawback of the route is the missing link in the city of Groningen, which still needs to be created. The route does have optimal priority for cyclists, where the province has done quite an effort to give priority to cyclists in two locations. It was difficult because outside the built-up area it is usually more difficult to make this happen, due to traffic speed for example. The crossings have been designed in such a way that cyclists can cross safely, for example with signs and levelling.

The planning process was done carefully with a broad perspective: the project was not only seen from a mobility perspective but from a broader spatial planning perspective. The Fietsersbond, natural organisations, local residents living on the route, farmers, and neighbourhood associations were involved in the ambition phase. Also in later phases, local residents living on the route, including farmers, were involved again. As a result of this, the grid structure is created in order to offer a route for agricultural vehicles next to the cycle path, while still keeping the area green.

5.3. Oude Spoorbaantracé Eindhoven - Valkenswaard

Route: Eindhoven - Valkenswaard (see figure 8)
Province: Brabant
Municipalities: Waalre; Valkenswaard
Current status: Completed (2015)

FIGURE 8: EINDHOVEN - VALKENSWAARD ROUTE (OBTAINED FROM MUNICIPALITY OF VALKENSWAARD DOCUMENT, 2014)

5.3.1. Document analysis

The document analysis for this case is done for the document "*Bestemmingsplan Oude Spoorbaantracé - toelichting "* by the gemeente Valkenswaard from 2014. In appendix B3 the raw results from the document analysis are presented.

The document analysis tells us that the policy makers have taken the CROW principles into consideration. They state all five, and give definitions. Cohesion is defined mostly as recognisability of the cycling infrastructure, and its function as a connection to other places. Directness remains a bit behind, with only some counts for terms such as 'a direct route', or 'straight route'. When looking at the route map, it can be observed that the route already is a straight line because of a historical train connection that used to be located along this route. Therefore a straight connection was already created before the actual planning started. Comfort is the principle that is most counted, followed by cohesion. The term comfort is defined as

a route with less as possible stops and nuisance. It is also stated that comfort and attractiveness are interrelated. Furthermore, the comfort is entailed by the width of the cycle path, which increases recognisability. The cycle path has only two crossings, where in one of them the cyclist does not have priority. Attractiveness and safety have clearly less counts than comfort. This could also be dictated by the already clear course of the route in a very early stage. For safety, most counts come from the notion 'no encounters with other traffic', which is promoted as one of the unique selling points of this route.

5.3.2. Interview 5 & 6

This section summarises the plain information obtained from the interviews about the cycle route between Eindhoven and Valkenswaard. The interviewees are Albert Burggraaf (project manager, gemeente Waalre) and Hans Oostelbos (beleidsmedewerker verkeer, gemeente Valkenswaard). An extensive summary can be found in appendix A7.

The interviewees consider the width, cyclists' priority, and directness most important when designing a fast cycle route. For priority, the ambition that the cyclist has priority on all locations was not fulfilled. There is one crossing where, due to traffic safety reasons, cyclists have to give priority to motorised traffic. On this location, there are 12 - 13 thousand vehicles passing by, which makes it unsafe for cyclists to have priority. Also for the width concessions had to be made for spatial embedding reasons, although according to the interviewees this has no severe consequences for safety and comfort, as the cycle route is located in a peaceful environment. It also was beneficial for the planning process, as more resistance could be expected when 4 meters was used. Attractiveness is considered important, as the choice for this course was made based on attractiveness. Alternative routes turned out to be inadequate because they were not direct, going along busy roads, and had many traffic lights and crossing traffic.

The route is going through a natural area with not many residents living on the route. Still, an participatory process was done in the first phases of the project. Besides the municipalities the groups that were included include people from the surroundings, people living on the route and natural organisations, who advocated for the natural values they were working with. In addition, the former users of the path, which was a bridle path, pedestrian path, and ATB route, were involved. Alternative routes were created around the current cycle route to fulfil the wishes of these users, where they eventually got more route options than they had on beforehand.

5.4. RijnWaalpad Arnhem - Nijmegen

Route: Arnhem - Nijmegen
Province: Gelderland
Municipalities: Arnhem; Lingewaard; Overbetuwe; Nijmegen
Current status: Completed (2015).

FIGURE 9: ARNHEM - NIJMEGEN ROUTE (OBTAINED FROM GOOGLE MY MAPS, 2019)

5.4.1. Document analysis

The document analysis for this case is done for the document "*Tracé - ontwerp RijnWaalpad"* by the gemeente Lingewaard and the gemeente Overbetuwe from 2010. In appendix B4 the raw results from the document analysis are presented.

The document analysis tells us that attractiveness and comfort received much attention, while directness, cohesion, and safety receive less attention. Directness is only mentioned a few times as 'a direct connection' or 'straight line'. Cohesion is mentioned as 'recognisability' quite often and 'freedom of choice', but this does not get counts for other terms. For safety, all kinds of aspects are mentioned, but only rarely. Just 'safe route' or 'traffic safety', or 'traffic safety near crossings' is mentioned more often. Attractiveness does get more counts, which are also more spread across different aspects. 'Landscape embedding' and 'social safety' do get many counts. Most counts go to 'separate cycle path' or 'away from motorised traffic'. For comfort, 'cyclists' priority' is considered as important, just as the creation of shelter possibilities.

5.4.2. Interview 7 & 8

This section summarises the plain information obtained from the interviews about the cycle route between Arnhem and Nijmegen. The interviewees are Martijn te Lintelo (mobility advisor at gemeente Arnhem) and

Wim van der Wijk (traffic engineer at RoyalHaskoningDHV). An extensive summary can be found in appendix A8.

According to the interviewees, safety is the most important principle. This is enhanced by an infrastructure that creates safety by itself, whereby a cycle path has a sufficient width (4 meters), a sufficient curve radius (RS20), minimal speed, minimal crossings, red asphalt, and is unbundled (detached from motorised traffic routes). Also sidewalks should be included. Another very important element is cyclists' priority, which enhances the comfort of a cycle trip. Comfort in general is entailed by a smooth surface, a non-stop character with priority and tunnels, and protection against wind. All these kind of elements have been the quality requirements throughout the entire process. These requirements have been agreed upon after the preparation phase, which also concerned the location of the route and costs. Attractiveness is also considered important, although the planners did not succeed to let the route go through *Park Lingezegen*, and instead let it go along the highway A325. This route was improved in terms of attractiveness, by the creation of a green buffer. In addition, on the entire route, 'points on the horizon' were created to enhance the multifarity of the route. Priority for cyclists has been implemented on a lot of places, while there was some scepticism among many in the beginning. The crossings were priority for cyclists was not implemented were too busy with cars, compared to the flow of cyclists. Also the creation of many under- and overpasses improved the comfort level of the RijnWaalpad. There have not been done many measures to protect cyclists from wind and rain.

The planning process is characterised by 'involvement when necessary on a local level'. On an upscale level, only the governments and the *Fietsersbond* were involved. A good example of local involvement, and an important player, is the *Park Lingezegen*. This is a park that is going to function as a green buffer between Arnhem and Nijmegen. It was involved relatively early in the process to look if the cycle route could be embedded well in the park. In the end, this did not succeed unfortunately. About area-oriented planning, the interviewees added that it is important to add value in order to reduce possible resistance. Although some planners are initially afraid that there will be resistance from the local residents, this does not have to be the case in every instance. For example, in Lent, people were happy because their street, which was only 9 meters of asphalt, would turn into a narrower street, with parking spaces and trees. Thus, if you add value to the local area, this might likely decrease resistance.

Although the interviewees are satisfied with the current route, they think they could have had more guts in the case of the *Lingezegen park*, in order to let the route go through that park more than it currently does. They have too quickly conceded to them. Another process thing that is important is a no-nonsense strategy. This means that, since the route is 26 kilometres long, it is important to focus on only the things that really have to be included, to make sure that the entire route will be implemented. If you focus on less relevant elements, there is a chance that the overall goal of the cycle route is not reached. Thus, you need to maintain a high quality, but you should not come up with all kinds of additions, such as shelter facilities and protection against wind. Also, it is important to create the entire route at once, because otherwise there is a chance that the missing parts will remain missing parts for 10 or 20 years. While doing this all, persistence throughout the entire process is very important. It took some discussions to convince everybody that the high quality requirements are really needed. Therefore it is important that you have people that have the knowledge ánd ability to persist. The fact that this has happened in the RijnWaalpad process makes it exist now as a high quality cycle route.

5.5. Fietssnelweg *F35 Twente*

Route:	Nijverdal - German border, with connections to Vriezenveen and Oldenzaal, connecting Almelo, Hengelo, and Enschede.
Province:	Overijssel
Municipalities:	Hellendoorn; Almelo; Wierden; Twenterand; Borne; Hengelo; Enschede; Oldenzaal
Current status:	Partially completed.

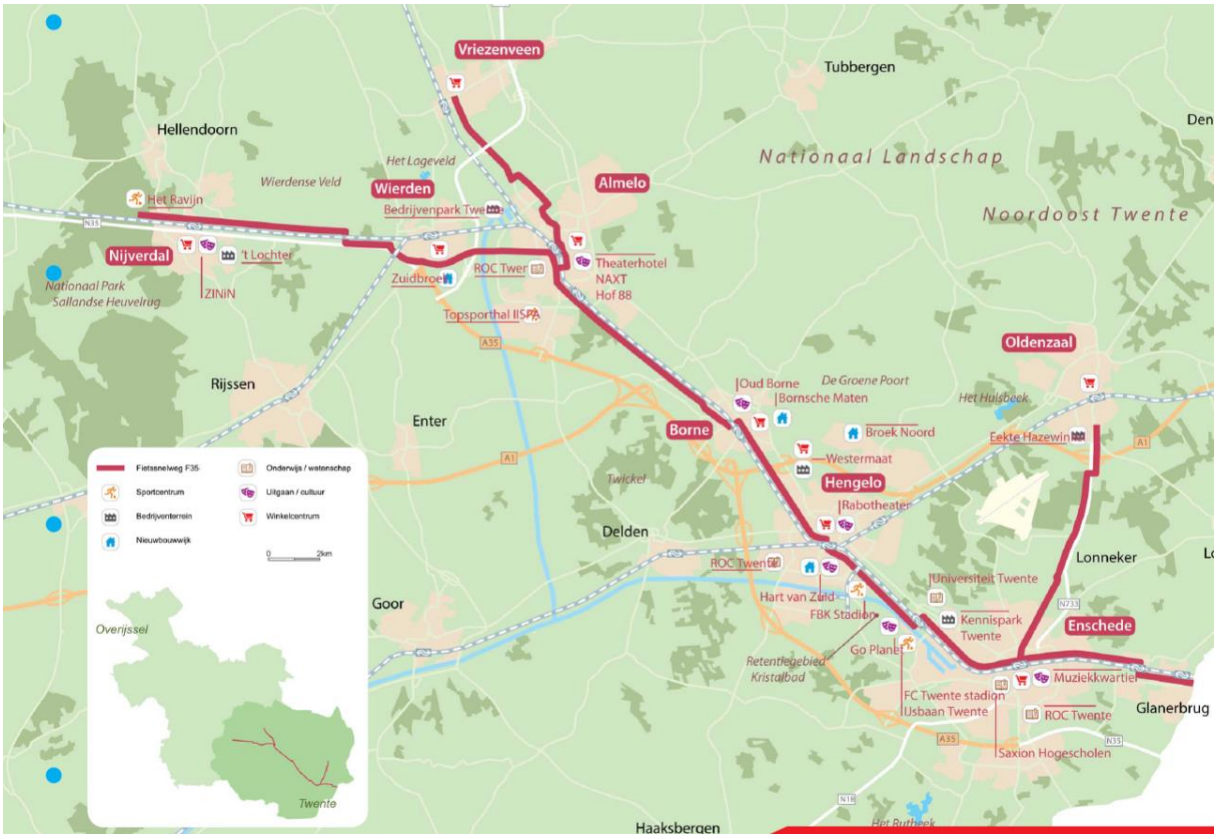

FIGURE 10: F35 ROUTE (OBTAINED FROM REGIOTWENTE AND GOUDAPPEL COFFENG DOCUMENT, 2014)

5.5.1. Document analysis

The document analysis for this case is done for the document "*Masterplan Fietssnelweg F35"* by RegioTwente and Goudappel Coffeng from 2014. In appendix B5 the raw results from the document analysis are presented.

The document analysis tells us that all five CROW principles receive attention in the Masterplan document. Only directness stays a bit behind, but not much. Directness receives most counts for terms that entail the high speed of the cycle route. Cohesion has different elements that account for the high score, but its most counts come from the route functioning as a network, with connections to all kinds of places. Also recognisability / findability is considered more often. For safety, many counts come from 'safety' or 'traffic safety'. Also notions about avoiding encounters with other traffic do get quite some counts. Attractiveness is mostly defined by an 'attractive route or surroundings', and by 'landscape or spatial embedding'. Comfort is entailed by a non-stop route, and a comfortable journey. There is also attention given to bicycle parking facilities.

Another thing that stands out is that fact that the project tries to *piggyback* with other spatial developments, such as the Masterplan of the station area of Almelo and the Burgemeester Schneidersingel in Almelo. The document also states that the F35 is an example of a project that stimulates an integrated strategy.

5.5.2. Interview 9, 10, & 11

This section summarises the plain information obtained from the interviews about the *Fietssnelweg F35* in Twente. The interviewees are Marjoline van der Haar (project manager at *RegioTwente*), Richard ter Avest (advisor at *Goudappel Coffeng*) and Kees Lems (traffic engineer at gemeente Enschede). An extensive summary can be found in appendix A9.

The interviewees stated that the non-stop character of a fast cycle route is the most important principle, with minimal intersections and minimal waiting time as characteristics. The F35 is considered successful because of the consistent and recognisable design of the cycle path: 4 meters wide, red, and smooth concrete (for both safety and comfort). Also, it is crucial that cars are prevented. Attractiveness is considered important by the interviewees, although they admit that the course of the F35 route has been lucky with the localisation through many natural areas. Still, they state that detours are allowed for a more attractive section. A route should be spatially embedded well in the urban and rural landscape.

In the first phases of the project, attractiveness was not yet a part of the plan, whereas comfort and safety were. The main focus was on creating a route that is non-stop and conflict-free. Besides being lucky regarding the attractiveness of the route, the route is also very direct as it is located along the railway line, therefore connecting city and town centres (which was the aim of the F35). Shelter facilities were not among the ambitions, and therefore neither implemented.

The ambition phase was executed by the local governments in collaboration with the Fietsersbond, and NS / ProRail. Other (societal) organisations and local residents only came into play at a later stage, where different local parts of the F35 were dealt with. One of the interviewees stated that a good spatial embedding is needed to make it not only attractive for the cyclists, but also for the surrounding environment.

To maintain a high quality, the most important element is the signed agreement. One needs to gain support among all involved governments. A unique feature of this project, and an important first step, is that eight municipalities were in favour of the F35. This is not very common. It is therefore essential to gain support from all involved governments first. It is important to make an agreement with all of them in order to have the governmental commitment signed on paper: something to rely on when discussions become tough and actors are likely to drop out. This agreement includes the course of the route, and its quality requirements. Thus, it is crucial to pay attention at the gaining governmental support phase. In this case, the *RegioTwente* was an important player who was able to bring those municipalities together. If the province would have done it, it would have been less close to the project. Although the quality requirements are signed on paper, it is still important to be persistent.

For the support among residents, it is important to create a piece of the route in order to let them see what a fast cycle route looks like. Initially, the image of a cycle highway is negative: a 'fast cycle route' or 'cycle highway' has a deterrent effect. However, after the first part of the F35 was completed, the enthusiasm among people about it increased a lot. For example, the planners persisted to make the entire route red, and they had tough discussions with nature organisations to let the route go through their natural areas. Because of the planner's persistency, both requirements were fulfilled in the end.

In the end, the following ten reasons can be given for why the F35 has a high quality:

1. Create a masterplan with clear agreements
2. Geographical position: the route fits next to the railway line and therefore connects city centres and town centres.
3. Four design requirements for quality: 4 meter *red carpet*, wide white concrete, lighting, F35 symbol.
4. Nice spatial embedding. There are parks and water features realised along the route (by chance).
5. Joint goal: go for it altogether (Twente engagement and collaboration).

6. Passion, enthusiasm, and knowledge of project group members.
7. Regular meetings (once every 6 six weeks since 2008)
8. Celebrate success (involve press)
9. Monitoring and communicate the results (involve press)
10. Long-term monitoring: counting and interviews, with good results.

6. | Discussion

This chapter discusses the results presented in chapter five, and compares them with and relates them to theories discussed in chapter two.

From the document analysis, it can be concluded that attractiveness and comfort get a significant share in the attention pie chart, compared to the other three principles. This is striking since according to CROW (2006) safety is the absolute number one principle for cycling infrastructures. This difference can have several explanations. For example, the documents can be intended to present the outstanding elements of the cycle route, such as a high comfort level, and an attractive environment, while other more basic principles are not discussed but do definitely get attention in practice. This is also what can be concluded from the interviews: directness and safety do indeed get significant attention in practice. Cohesion is the only term that remains a bit behind in general, probably because the focus of a single cycle route is not to create a complete network, but solely contributing to it. The F35 case however shows us that this focus on a network instead of a straight line pays off in the end when looking at user rates. Another explanation could be the broader focus of attractiveness and comfort, i.e. there are more elements that fall under attractiveness and comfort, which can also be observed in theories. Whereas directness and cohesion focus on the total route being short, connecting to different places, and being recognisable (CROW, 2006; Heinen et al., 2010), attractiveness and comfort focus on the more local and practical elements such as location near roads, the use of greenery, lighting, spatial embedding, priority at crossings, and a smooth surface (CROW, 2006; Bohle, 2000; Vis, 1994; Heinen et al., 2010; Mossel, 2018). Safety is mostly about the curves, having no obstacles on or near the cycle path, and minimising encounters with other traffic. This is in line with theory, which is discussed below.

The theoretical perspective and practical perspective on cyclist's safety do show some similarities, but also crucial differences. The theoretical perspective gives a more broad view of safety, which entails minimising risky behaviour, not mixing fast and slow traffic, minimising encounters, and awareness raising (CROW, 2006; Hamilton-Baillie, 2008; Dufour, 2010). From the practical perspective it can be argued that it considers safety more as facilitating risky behaviour, by designing a wide cycle path with wide curves and no bumps and holes. The actual practical implementation of the theoretical notion of 'minimising risky behaviour' of course leaves room for discussion. Another difference is that practitioners focus on the actual safety, while perceived safety is not considered important. Similarities of theory and practice are that crossings should be minimised and fast and slow traffic should not be mixed (unbundling). Further, asphalt or concrete should be red for recognisability. All this information cannot be found back in all cases, but only for Apeldoorn - Epe, RijnWaalpad, and the F35. Sometimes, elements that fall theoretically under comfort are in practice considered as safety elements, such as a sufficient width of the cycle path.

Theory defines attractiveness as a variety of multiple factors. Practice tells us that this is still the case, but only a bit narrower focused. As described in section 2.7, attractiveness is composed by the localisation of cycle paths as a separate entity far away from major roads, and spatially embedded well in surroundings that are omnifarious, green, and open, but also socially safe (sufficient lighting) (Hagemeister et al., 2005; Bohle, 2000; Vis, 1994). Practice is much more focused on the spatial embedding of the cycle route, where the inclusion of greenery and localisation away from motorised traffic are some of the smaller factors contributing to that. A variety of landscapes is found back to a smaller extent. Several interviewees mentioned the relation between attractiveness and directness, whereby attractiveness is sometimes preferred over directness: a small detour is allowed for a more attractive route. The definition however, also in practice, is still rather vague. For example, attractiveness is sometimes framed differently from what is done in theory. In the Groningen - Ten Boer case, attractiveness is not defined as a separate principle, but as a combination of all other four CROW principles. In other words: it is a matter of definition. It can be discussed whether this has an influence on the implementation of attractiveness, when it is not considered as a separate principle. The fact that the Stadsweg route between Groningen and Ten Boer is valued positively by its users because of its attractiveness is an argument in favour of not defining attractiveness as a separate entity, since it can still be found back in practice. The question is whether this is generally applicable.

Comfort's theory and practice do show many similarities. The most important and often appearing element in the documents and interviews is the non-stop character of a fast cycle route, which is also found in the core definition of comfort (no delay, CROW, 2006). In practice, this is entailed by priority for cyclists, and having no intersections or conflicts by creating under- or overpasses. Also the width of the cycle path is considered a very important factor in practice, although some practitioners prefer to put this under safety instead of comfort. There is some overlap in reality. The same holds for a cycle path with a smooth surface (no bumps and holes). A striking result is that shelter facilities are often ambitioned, but never implemented. These ambitions are mostly found back in the document analysis, which is thus in line with the theory that comfort is about minimising weather nuisance (Heinen et al., 2010). The interviews however show the opposite: shelter facilities and wind protection are not considered relevant when it comes to implementation of the cycle route.

Practice and theory do have a similar basis when looking at safety, attractiveness, and comfort. A good clarification for this is the fact that the five CROW principles are often used by practitioners. They are found back in documents, but also all interviewees were able to name and explain these principles, in which their interpretation also showed considerable similarities with the other theories about safety, attractiveness, and comfort (besides the CROW framework itself). An only difference is that practitioners are sometimes a bit more focused on the technical aspects instead of being more broad (e.g. sufficient curve width). The most often found back principle of this cycle route is the non-stop character, which is also considered the unique selling point of a fast cycle route, as often mentioned in the interviews. A fast cycle route could therefore better be called a non-stop cycle route, since speed is not the most important, but the ability to cycle continuously without stopping.

A caveat should be made regarding the similarities between theory and practice. Practical knowledge is obtained from the perspective of project managers and other planners that were involved in the projects. It must be noted that this may lead to a one-sided view on how the project has been implemented regarding the five principles, i.e. this could lead to a biased (more positive) image, while reality may differ. Therefore, it would be better to have a 'contra perspective' that takes a more critical stance. This could be an external party that was in some way involved in the project, such as the *Fietsersbond*, or a group of regular users of the cycle route. The 2019 ANWB research tested three of the five cycle routes in this research: Doorfietsroute Groningen - Ten Boer, the F35 Twente, and the RijnWaalpad. Conclusions from the ANWB are that Groningen - Ten Boer has more defects compared to the F35 and the RijnWaalpad. Groningen - Ten Boer had the lowest score, while the F35 and the RijnWaalpad had the highest scores. These conclusions are rather similar to the conclusions from this research. For Groningen - Ten Boer, the planners did not stick to the width requirements, for example (3 meters instead of the 4 meters requirement). The fact that the RijnWaalpad and the F35 turned out to be the best routes can also be traced back to the process dynamics results of this research. The interviewees of the RijnWaalpad and F35 stated explicitly that persistence and political guts are important elements to get to a high quality cycle route, while for the other three cases this is less prominently present. Thus, the ANWB research can give us a better overview of the actual implementation of the cycle route. Still, a fully fledged contra perspective is necessary to discover the real dynamics of the planning process while being most certain that knowledge is not biased into a positive direction.

An essential theoretical link of this research is the one made by Koglin (2015) that an area-oriented approach is beneficial for increasing cycling activities. For many cycle routes' planning process, a regional entity (e.g. *RegioTwente*, *Cleantech regio*) was the coordinator of the process since they were considered most suitable to bring the different actors together, and being on the level that is the closest to the particular project. A fast cycle route crosses boundaries and is therefore too big to handle only on municipal level, and too small to handle on provincial level. This is also in line with the theoretical notion that infrastructure development should be integrated with the local and regional functions, which have their own interests and stakeholders (Heeres, 2017). From the interviews it can be concluded that almost all projects have made use of this notion, either consciously or unconsciously. All projects clearly showed that they involved local stakeholders and therefore took the surrounding area into account, while also keeping an eye on the cyclist's

perspective. In other words, both the inside-out (infrastructure → area) and the outside-in (area → infrastructure) are often used (Arts, 2007). The municipalities were in all cases main players in the planning process. The type and timing of involvement differs per case, but in general local residents, farmers, neighbourhood associations, and village councils were consulted somewhere in the process. The involvement of most cases started relatively late, when the design of separate parts of the route started. Sometimes this is done to prevent unnecessary rumours among residents, since a fast cycle route does have a deterrent effect for many people. For three cases (Apeldoorn - Epe, RijnWaalpad, and the F35) it was even clearly mentioned that a good planning process where also surrounding demands are considered is beneficial for the entire area, i.e. for both the cycle route users and the surrounding functions. Thus, it can indeed be stated that an area-oriented approach is used to foster the safety, attractiveness, and comfort of a rural cycle route.

The prioritisation of safety, attractiveness, and comfort does have dynamics throughout the planning process. All three have a different level of concreteness: safety is most concrete, while attractiveness is most vague. Comfort is in between those, being more concrete than vague. This is also in line with theory that attractiveness is a matter of intersubjectivity, thus relating to different perceptions of users (CROW, 2006; Dufour, 2010). This difference in concreteness has implications for the process. The most concrete elements are clear relatively early in the process. Therefore safety gets most attention in the ambitions phase. It is also mentioned often that safety was one of the main reasons for starting the project. Attractiveness comes into play at a later stage than safety and comfort, and has therefore less priority in the ambitions phase. After the design phase is completed and most elements are clear, it is examined how the route can be made more attractive. At the one hand, this is striking since attractiveness has a lot to do with the localisation of the route, both in theory and practice (spatial embedding, away from roads, through nature) (Bohle, 2000; Heinen et al., 2010), and therefore one would expect attractiveness to pop up early in the process. On the other hand, as mentioned before, it sounds logical that a more vague concept needs to be concretised throughout the process and should therefore pop up later in the process.

The question however is, is it possible to remain the qualities of safety, attractiveness, and comfort high while such dynamics occur? From the interviews it can be concluded that planners put a lot of effort into this aspect, as they consider it to be essential for the success of the project. Many interviewees stated they were indeed successful in their efforts because of several aspects. First of all, in the very first phase, it is important to gain support among all involved governments. This should not be just a verbal agreement, but signed on paper, including all the high quality standards that are required for the entire route. Then, it is a matter of persisting and focusing on the important parts (no-nonsense strategy). You need to stick to the ambitions as long as possible: only make concessions when no other choice is left, preferably after the preliminary design phase. Also, when facing fear among the local residents, it is good to make sure that at least one part of the cycle route is realised, because then people actually see what it looks like in reality. In most cases, opinions then change from negative into positive. Furthermore, it is crucial to have enough political guts, mostly for showing the importance of the creation of the cycle route. Only for the case of Groningen - Ten Boer no signs were found that this constancy was a main issue in the process. This can immediately be found back in reality, when looking at the width and the sudden ending (missing link in Groningen). For the latter, a lesson could be drawn from the RijnWaalpad case, where it was considered important to not postpone certain parts of the route, since this will lead to an unwanted long delay or even cancellation, thus making the cycle route incomplete.

7. | Conclusion

For this research, several conclusions can be drawn. First, all research questions are answered separately, after which a general conclusion is drawn. When asking the question "How is safety, attractiveness, and comfort getting attention in Dutch bicycle plan decision documents?" one can state that in decision documents especially attractiveness and comfort get attention, which is probably due to the preferences of the planners about what they wish to promote the most, and due to attractiveness and comfort having a more broad focus than the other three principles, both in theory and in practice. Safety in documents is mostly entailed by an infrastructure that causes no accidents, i.e. well-designed curves, no obstacles, and minimal encounters with other traffic. A striking difference is that practice does not focus on perceived safety while theory does. Attractiveness entails a good spatial embedding, localisation near roads, greenery, and lighting. Comfort is about priority for cyclists, a smooth surface, and no long waiting time at traffic lights.

When looking at practice ("How are safety, attractiveness, and comfort approached and implemented in Dutch bicycle planning practice?"), it can be concluded that there are some differences from what is promised in the documents. While the documents gave most attention to attractiveness and comfort, practice is focused on all five principles, in which the interpretation of those principles is similar to theoretical perspectives. The planning process of those principles is characterised by involvement of several different stakeholders, where the municipalities and (sometimes) a regional body are in the lead. Area-oriented planning, which is beneficial for cycling pleasure, can definitely be found in the planning process of fast cycle routes, although the involvement of local stakeholders starts relatively late in the process most often. Involvement of local residents living on the route is considered necessary but one should prevent causing unnecessary rumours in the early stages, since the word 'fast cycle route' or 'cycle highway' has a deterrent effect for local residents.

The earlier mentioned characteristics of safety, attractiveness, and comfort need to be implemented in desired qualities. Since the planning of bicycle infrastructure is a dynamic process, there are also dynamics within the prioritisation of safety, attractiveness, and comfort. Safety, just as comfort (to a lesser extent), has clear guidelines and is therefore relatively clear from an early stage, while attractiveness does not have these clear guidelines and therefore needs to be defined throughout the process, in order to be taken into account later. It can therefore be stated that the initial focus is on safety (and comfort to a lesser extent), while attractiveness comes into play later. Since in the end, all principles need to be in an optimal state, it takes a lot of effort from the planners to bring all these elements to a desired level.

The answer to the question "How do the planners deal with potential prioritisation dynamics throughout the planning process?" can give future planners recommendations on how to deal with dynamics. The following recommendations are based upon what planners both have done in reality, and what they would have done when looking back afterwards: To remain the qualities of safety, attractiveness, and comfort high, planners should in the first step gain support among all involved governments by a signed agreement. Afterwards, throughout the entire process, a persistence and no-nonsense strategy is necessary. Quality ambitions should remain high until no other option is left, and one should focus on the important parts and not get distracted by redundant elements, which could lead to a failure of the project in general. Political guts are essential for fast cycle routes in order to indeed keep ambitions upright up and until implementation. The previously-mentioned elements are mostly found in the F35 and the RijnWaalpad cases, which also led to the success of the cycle route from various perspectives. This is less found in the other three cases.

In general, rural cycling projects, and fast cycle routes in particular, do come with a broad range of requirements in order to be implemented successfully. These requirements come in a variety of styles which make cycling infrastructure planning dynamic and require great efforts from those executing it. Dutch planners approach rural cycling in a fairly area-oriented style, by basing their quality requirements for safety, attractiveness, and comfort on scientifically grounded advices, both in their documents and in practice. The planning approach that enables these qualities to be high after implementation is characterised by signed agreements, persistence, a no-nonsense strategy, and political guts. Only this will lead to a pleasant bicycle trip across the countryside.

8. | Reflection

This chapter reflects on the strengths and weaknesses of this research, its usability, future use, and its methodology.

In general, this study gives a good overview of how theory and practice interlink and make use of each other. It showed that practitioners do indeed make use of academic suggestions, such as the ones about safety, attractiveness, and comfort. A good thing for example is that this information is obtained from two different sources: documents and interviews, which makes it more reliable. However, there are some drawbacks to this research, which are discussed below.

First of all, the theoretical descriptions of directness, cohesion, safety, attractiveness, and comfort differ not only in content, but also in type and scale. For example, safety can be described quite clearly with guidelines that are prescribed, while attractiveness is much more subject to intersubjectivity. This difference in type means that they should be approached differently, which makes it difficult to compare them in a reasonable manner. The same holds for the difference in scale, or variety. Namely, in theory, but also in practice, it can be observed that attractiveness and comfort entail more different elements than for example directness. In other words, directness is mostly about one aspect, while attractiveness is an accumulation of different aspects. Therefore the document analysis has its limitations since the range of concepts of some principles are bigger than others, possibly leading to bigger shares of those principles.

About the document analysis it should be taken into account that not all documents are of equal styles, dates, and authors. Some documents are from the very start, some from a bit later, and some documents are zoning plans, while others are more in a masterplan style written by consultants. This may have some influence on the counts of the five principles since it is the type of document and its authors that determine what is emphasised.

The case selection is also an important factor in this research. Since the number of cases is low, this leads to useful in-depth information, but also to less cases. This has two interrelated consequences. First, it is more difficult to obtain a general overview. Second, it means that the results are dependent on the case selection. Currently, there are many fast cycle route in the Netherlands implemented, or in development. It looks like that the cases in this research show a decent image of the planning processes around bicycle infrastructures, but in reality this might differ. Since many interviewees indicated how their project was successful, the conclusion of this research could also be seen as an advice besides an informative text about the general cycling infrastructure planning processes in the Netherlands. A good thing about this is that future projects could benefit from these conclusions in their own processes. Regarding the general applicability of the conclusions, it would be good if a case in the western part of the Netherlands had been included in order to give a broader overview of cycling infrastructure planning in the entire country.

This research also contains some elements that are suitable for future research. First of all, there is a next step to be followed after completion of this research, which is the application of this knowledge. The Netherlands is known for its progressive cycling infrastructure planning. The lessons learned from this research can therefore be used in other projects as well. How can these suggestions help in other cycling infrastructure projects, such as in other countries?

The intersubjectivity as discussed in section 1.2 has many influences on the perception of cycling, especially attractiveness. Although it is clear that this intersubjectivity is out there, but the questions is how to deal with that specifically? For example, when is something well embedded in the landscape? These are questions that could be part of a future research.

In addition, the area-oriented style was found back in practice, as seen in the interviews. Although there is a theoretical relationship between an area-oriented style and cycling activities, it is not clear whether this is the case for fast cycle routes specifically. In other words: does the link between and area-oriented style of planning and increased cycling activities also exist for fast cycle routes? And if yes, how?

Lastly, it could be interesting to see why theory and practice differ regarding the inclusion of weather shelter facilities one striking result is about the inclusion of weather shelter facilities. Theorists stated that cyclists prefer to have these kind of facilities on the route, but practitioners said the opposite. A further investigation of this would help in clarifying why this particular aspect deviates from the other results.

9. | References

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