The design logics behind Dutch cycle highways

An explorative research on the top-down staging of cycle highways in the Netherlands

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Abstract

Initially cycle highways were designed to get car commuters out of their cars and onto their bicycles by providing fast and efficient routes. However, societal developments and changing travel patterns pose the question whether this rhetoric behind the design of cycle highways is still accurate. Some have even argued that this car-based rhetoric was never successful for the design of cycle highways. Instead, the unique perspective of cyclists, their embodied experiences and motives should be considered. This research explores to what extent and how different cyclist types and cycling experiences are considered in the design of cycle highways in the Netherlands. In doing so, it takes the practitioner's perspective to research how cycle highways are staged top-down. Insights are inquired through a multiple case study using semi-structured interviews and document analyses. The results show that practitioners view the cycle highway concept through two different logics. The car logic targets car commuters to make the switch through a design that focuses on directness, efficiency and speed. This is informed by principles from the conventional transport paradigm. The bicycle logic targets commuting cyclists and aims to facilitate an optimal cycling experience through a design that focuses on the activity itself and attractiveness of the route. This is informed by principles from the sustainable mobility paradigm. Even though most practitioners are aware of the importance of the cyclist perspective, there are many institutional factors that push for a car-based design. These include the CROW design guidelines, financial constraints, stakeholder interests and physical limitations. By reflecting upon current academic works, this study argues for a reconsideration of the design guidelines by paying more attention to the subjective side and allowing for flexibility in the design. Furthermore, the current cyclists should not be forgotten when designing cycle highways. These reflections are valuable contributions to the design of successful cycle highways and the transition towards sustainable mobility. Furthermore, the findings of this study add to the current knowledge on how mobilities of Dutch cycle highways are staged top-down through transport and mobility paradigms and institutional factors. With that it opens an avenue for future research on the bottom-up staging of cycle highway mobilities.

Keywords: cycle highways, design, cycling experience, cyclist types, staging mobilities, transport and mobility paradigm, institutional factors

1. Introduction

> "The world will need much more cycling if we are to overcome climate change, the most urgent crisis of our times. If we succeed, the 2020s could be the decade when the way we transport ourselves stopped being the problem and became part of the solution." (Swarttouw, 2021, p.1)

With this statement the European Cyclist' Federation (ECF) stresses the importance of cycling investments in order to act upon some of the world's prominent challenges. Not only is the bicycle a net-zero emitter, it also delivers a range of positive societal impacts such as reduced air pollution and traffic congestion, improved health and wellbeing and more livable cities (Swarttouw, 2021). The Netherlands is a forerunner when it comes to the popularity of cycling. On an average weekday in the Netherlands, the Dutch go on about 14 million cycling trips. Cycling is a means for everyday transportation not just for students, sportsmen or the ecologically minded, but for everyone, even the Dutch prime minister (Kuipers, 2013). This Dutch cycling culture offers opportunities for tackling contemporary problems as described by the ECF. The former director of the Dutch cycling association, Saskia Kluit, also acknowledged this by arguing: "On a daily basis 500,000 cars are involved in traffic congestions. If 10 percent of these drivers take their bicycle, traffic congestions will be history" (Kluit, 2017). The plea to get commuters out of their cars and onto their bikes is further supported by recent cycling innovations.

Through technological developments the e-bike and speed pedelecs have taken their place in the cycling scene. Whereas in 2013 less than 200.000 new e-bikes were purchased yearly, it has risen to more than 420.000 in 2019 (De Haas & Hamersma, 2020). Approximately 18% of the cycling trips are taken by e-bike and 26% of the traveled cycling distances are accounted for by the e-bike. This amounts to more than 700 million e-bike trips covering more than 4.1 billion kilometers in the Netherlands (De Haas & Hamersma, 2020). Electrically driven bikes allow people to travel faster and for longer distances. Trips that are taken by e-bikes are over 60% longer in distance than those by the traditional bike (De Haas & Hamersma, 2020). In line with these technological developments, a fairly new type of cycling infrastructure has emerged: the cycle highway. Like the name already suggests, cycle highways were initially planned for fast and direct commuting over long distances (Sørensen, 2012). In this sense, the logic behind the cycle highway seems closely connected to that of the car highway. However, societal developments and consequent changing travel patterns pose the question whether the initial logic behind the cycle highway concept remains accurate.

The unprecedented covid-19 pandemic has affected many different domains of society, including our travel patterns. Social distancing measures have influenced the number and type of out-of-home activities people perform. Working from home, hybrid education and a reduced number of activities and events have resulted in decreased directed travel demands (De Vos, 2020). In the Netherlands, almost half of the employed workforce indicated to work fully or partially from home at the end of 2020 (TNO, 2021). Next to this, there has been an increase in undirected travel trips in which people travel for the sensation of speed, the exposure to the environment and scenic beauty (De Vos, 2020). Active travel such as cycling is further valued and stimulated through the increasing use of fitness trackers and sharing platforms. As a consequence of such developments, the people that cycle, why they cycle and how they experience the activity are in constant flux.

Hence, the conventional rhetoric behind the concept of cycle highways based on fast and direct commuting is challenged. Practitioners Sargentini and Valenta (2015) even argue that this car-based rhetoric was never a successful logic for the design of cycle highways. Instead they should consider the cyclists' embodied experiences and take individual motives into account. Designing for optimal rider experience is important in ensuring that cycle highways are used and that the user benefits from the investment (Millar et al., 2021). The call for considering the uniqueness of the cyclist's perspective in planning for cycling infrastructure also becomes evident from academic literature.

The sustainable mobility paradigm, introduced by Banister (2008), criticizes the conventional transport paradigm that mainly focuses on the physical dimension of transport. It views travel as a derived demand in which speed and minimal travel time are prioritized. Instead, the sustainable approach focuses on the social dimension, how travel can also be a valued activity to people and argues that travel times have to be reasonable. In line with this, Forsyth and Krizek (2011) have shown that cyclists have an unique perspective compared to motorists and pedestrians. According to them, the dominant focus on safety and better connections hampers the consideration of cycling experience. In response to the recognized importance of cycling experiences, Liu, Krishnamurthy and Van Wesemael (2018) have contributed to the theoretical debate by conceptualizing cycling experience as a social, sensory and spatial phenomenon. Even though the cyclist perspective receives increasing attention from a theoretical perspective, the practical perspective remains largely absent. One study by Liu, Te Brömmelstroet, Krishnamurthy and Van Wesemael (2019) explored the role of user experiences in the design of cycle highways from a practitioner's point of view. By applying an European scope, which included two practitioners from one Dutch project, they studied the concept in a broad sense. Liu et al. (2019) further suggest future research to focus more extensively on specific contexts in addition to their broad European scope. The current research will respond to this call by exploring the considerations of cyclist types and cycling experiences in the context of Dutch cycle highways in more depth. By doing so, it will also touch upon institutional factors that may influence whether different cyclist types and experiences are considered in the eventual design. Hence, the following research questions are central in this study:

Main research question: *To what extent and how are different cyclist types and cycling experiences considered in the design of cycle highways in the Netherlands?*

Sub-research questions:

- How is the cyclist perspective considered by the contrasting design logics: the conventional transport approach and sustainable mobility paradigm?
- What institutional factors can influence the design logic behind cycle highways?
- To what extent do current developing designs of Dutch cycle highways follow the conventional transport or sustainable mobility logic?
- How are current developing designs of Dutch cycle highways influenced by institutional factors?

By exploring these particular questions, this study aims to contribute to both theoretical knowledge on staging mobilities in the Dutch cycle highway context and add practical insights on the transition towards sustainable mobility. First, regarding the theoretical contributions, this study will adopt one of the two perspectives proposed by Jensen's (2013) Staging Mobilities and

complement it using the two paradigms by Banister (2008). According to Jensen (2013), mobilities are both "carefully and meticulously designed, planned and 'staged' from above" and "acted out, performed and lived as people are 'staging themselves' from below" (p.4). Hence, mobilities are explained by the interactive process between 'staging' and 'being staged'. An important starting point in Jensen's model is the creation of the infrastructural scenes in which everyday-life mobilities take stage. The current study will therefore focus on the 'staging from above' perspectives in the case of cycle highways in the Netherlands. It conceptually connects the two paradigms by Banister (2008) to explain potentially varying perspectives of practitioners. The focus on the extended top-down perspective of Jensen allows for an in-depth exploration of cyclist design considerations and intervening institutional factors in multiple cycle highway case studies. Hence, the results of this explorative research are valuable for understanding how cycle highway mobilities are staged from above. Furthermore, the results provide an insightful basis for comparison with research that focuses on the 'staging from below' perspective in the Netherlands.

Second, this study aims to contribute to the transition towards sustainable mobility. Cycling innovations such as the cycle highway concept promise to aid such transitions (Te Brömmelstroet et al., 2020). However, like Millar et al. (2021) have argued, this promise is dependent upon how cyclists' experiences are considered in the developed infrastructure. By exploring how cyclist types and experiences are considered in the design of cycle highways this research provides practical insights in the Dutch context. More specifically, by exploring what is done now and providing reflections upon this using theoretical knowledge. The results of this study can be useful for practitioners and policy makers who aim to contribute to the modal shift by developing cycle highways or their design guidelines.

The following chapters explore the logic behind the Dutch cycle highways step-by-step. First, a thorough literature review will address the main concepts. By doing so it addresses the first sub-research question about the contrasting conventional transport and sustainable mobility paradigms and their consideration of the cyclist perspective. Chapter three touches upon the institutional context that Dutch cycle highway planning finds itself in. It elaborates upon several institutional factors that may influence the design. Chapter four elaborates on the methods that were used to conduct this study. It is followed by chapter five in which the results of the data analysis are shown. The discussion of these results in general and in comparison to existing literature is central in chapter six. Finally, chapter seven covers the conclusion of this study.

2. Literature Review

2.1 Cycle Highway

'Cycle highway', 'fast cycling route', 'greenway' and 'through cycling route' are all names that have been given to a new type of cycling infrastructure that encourages long-distance cycling. One overarching definition and guiding principles of the concept are still lacking internationally (Liu et al., 2019). Kristjansdóttir and Sjöö (2017) investigated the different characteristics of cycle highway routes in Europe and identified the following common features: high-quality standards, certain minimum length, exclusively for cyclists and designed for high speed. Within the Netherlands, the dominant definition for cycle highways is provided by the Dutch independent knowledge platform CROW, stating "the term used for high-quality regional bicycle routes which main purpose is to facilitate journeys by bicycle over distances from 5 to 30 km" (CROW, 2016; Kristjansdóttir & Sjöö, 2017, p.7). This definition is further concretized by five guiding principles: cohesion, directness, attractiveness, safety and comfort (see chapter 3). These principles can inform the design of cycle highways. The term design can be used as both noun and verb. A product and a process. When speaking of the design of cycle highways, this study refers to the former, being "a drawing or plan from which something is made" ("design," n.d.). Nevertheless, this study will also touch upon the process side that precedes the 'eventual design' (see §2.4).

Even though cycle highways may have different definitions and specifications, the behind lying motivations for governments to invest in this type of road infrastructure are often similar. According to Liu et al. (2019) cycle highways are generally framed within a package of interventions that intend to change commuting behavior. Academic studies on cycling behavior have found that cycling becomes relatively less attractive in comparison to other modes as trip distances increase (Heinen, van Wee & Maat, 2010; Scheepers et al., 2013; Liu et al., 2019). The cycle highway responds to this finding by providing high-quality long-distance cycling routes. Therefore, attempting to make cycling an attractive modal choice for commuters. According to Liu et al. (2019) survey data from European governments suggest that users of cycle highways indeed do tend to take longer trips than the average cyclist. Especially with the expected commuter traffic growth, investments that stimulate a modal shift are argued to prevent more traffic congestions in the near future (Skov-Petersen, Jacobsen, Vedel, Thomas Alexander & Rask, 2017). In addition to the intent to change commuting behavior, Rayaprolu, Llorca and Moeckel (2018) argue that the Dutch concept of cycle highways is a response to a broader range of societal developments. Namely, "rising environmental and health consciousness, and the growing popularity of electric bicycles" (Rayaprolu et al., 2018, p.662). The latter argument implies a reaction to accommodate for the needs of society, the cyclists and thus the users of the cycle highways. Whereas, the former considers these potential users as subject to behavioral change with regards to their modal choice. Both of these arguments behind the development of cycle highways show the connection with, and importance of considering the users, which will be touched upon in the next section.

2.2 Cyclist Types

In order to properly plan cycle infrastructure, it is key to know and characterize the transportation demand. Recognizing the differences between the needs and requirements of different types of users can aid bicycle infrastructure planning (Poliziani, Rupe, Mbuga, Schweizer & Tortora, 2020). Cyclists are a heterogeneous group for which bicycle policies have different effects. This is due to the cyclist's specific characteristics (Damant-Sirois, Grimsrud & El-Geneidy, 2014; Kroesen &

Handy, 2014) and varying route and infrastructure preferences (Larsen & El-Geneidy, 2011; Stinson & Bhat, 2005; Veillette, Grisé & El-Geneidy, 2019). Many studies have attempted to provide a cyclist typology through survey data by focusing on varying factors. Haustein and Hunecke (2013) distinguish four types of factors that are most often used in academic research to develop a typology of traffic user groups. Below it is argued that the following three are mainly useful: travel behavior, sociodemographic variables and attitudes. Some studies have also used multiple factors in combination. Every segmentation approach has its own pros and cons.

Travel Behavior

A segmentation approach based on travel behavior factors looks at for instance trip frequency, mode choice or trip purpose. Kroesen and Handy (2014) mainly looked at trip purpose and frequency to cluster people into four groups: *non-cyclists*, *non-work cyclists*, *all-around cyclists* and *commuter cyclists*. Hereby thus considering whether they are cyclists or non-cyclists and cyclists for work or non-work purposes. In a similar way, Sottile, Diana, Piras, Meloni and Pirra (2020) considered trip purpose and frequency, but distinguished three groups also based on socioeconomic and attitudinal characteristics. The three groups were: *utilitarian cyclists*, *hedonic cyclists* and *non-cyclists*. A segmentation approach based on travel behavior factors is mostly descriptive and can be useful to show developments of certain cyclist groups over time (Haustein & Hunecke, 2013). However, it does not provide insights on the underlying mechanisms that affect travel behavior. The cyclist typology by Bergström and Magnusson (2003) considers the influence of seasonal weather conditions together with trip frequency. They developed four types of cyclists: *winter cyclists*, *summer-only cyclists*, *infrequent cyclists* and *never cyclists*. According to their study, the cyclists that cycle all year round are mostly motivated by the physical training element. The summer-only cyclists view road and weather conditions as potential obstacles and infrequent cyclists and never cyclists are mostly influenced by travel time. The study by Bergström and Magnusson (2003) shows that including other factors such as physical training and road conditions provides additional insights to why people show certain travel behavior. This is useful information for the development of policy interventions.

Sociodemographic Characteristics

The second segmentation approach considers the sociodemographic characteristics of traffic users. According to Haustein and Hunecke (2013) age and gender are the most commonly used factors in such segmentation approaches and often combined with a set of other sociodemographic variables. Combining such variables allows for identification of life cycle stages that often show different travel patterns. Christiansen, Madsen, Schipperijn, Ersbøll and Troelsen (2014) studied adult life stages and transport behavior in the Danish context and found that young adults without children cycle more than parents and midlife adults, independent of neighborhood cyclability. According to Haustein and Hunecke (2013) segmentation based on sociodemographic variables has two main benefits. First, these variables are relatively easy to measure, often well accessible and have high validity. Second, groups based on sociodemographic variables are relatively stable over time. A downside is that travel behavior cannot solely be explained by sociodemographic variables alone, which is why they are often combined with attitudinal variables.

Attitudes

Personal attitudes are necessary to understand individual travel behavior (Haustein & Hunecke, 2013). Research on mobility types have increasingly included attitudinal variables as a

segmentation approach to for instance develop cyclist typologies (e.g. Haustein & Møller, 2016; Li, Wang, Yang & Ragland, 2013). A Danish study by Haustein and Møller (2016) developed three e-bike cycling groups based on cycling attitudes and motives for the use and purchase of e-bikes: *enthusiastic e-bikers*, with most positive attitudes towards e-bikes and are motivated to increase their cycling frequency; *utilitarian e-bikers*, who are regular cyclists that mainly use their e-bike for practical purposes and reduce travel time; *recreational e-bikers*, who are very positive about the e-bike but use it less often and mainly for long-distance recreational trips. Policy interventions based on such cycle groups can target attitudes that are subject to change. It therefore provides opportunities to influence mode choice or travel behavior in general. However, the measurement of attitudes contains higher risks of measurement errors, which should be considered as well (Haustein & Hunecke, 2013).

Based on Haustein and Hunecke (2013) a fourth way to group different types of cyclists is by focusing on spatial variables. These typologies focus for instance on neighborhood attributes and infrastructural qualities to explain differences between cyclists. However, such typologies often take spatial characteristics as determinants for certain attitudes of cyclists that are differential. A well-known typology by Geller (2006) illustrates this: *no way no how*, *interested but concerned*, *enthused and confident*, *strong and fearless*. The segmentation is based on the user friendliness of different types of infrastructure that were defined by a traffic expert (Geller, 2006). As such, the infrastructural qualities are linked to the cyclist's concern about personal safety and is therefore argued here to be mainly an attitudinal segmentation approach. A limitation of Geller's typology is that it is based on expert knowledge and therefore largely subjective. Dill and McNeil (2013) showcase this limitation by identifying inconsistencies in Gellers typology between the behavior of cyclists and their assigned group. For instance, a significantly larger percentage of the *strong and fearless* group appears to be non-cyclists. Whereas this percentage is much smaller among the *enthused and confident* and *interested but concerned* groups.

Combining factors

As shown, many studies have considered one or two of the three types of factors to create a typology of cycle groups. However, it limits matching policy interventions to target only the variables that were considered. The study by Damant-Sirois et al. (2014) created a multidimensional typology of cyclists in which they combined 35 variables that formed seven factors that were mostly proven determinants of the intensity of bicycle usage. The four distinct cyclist types were: *dedicated cyclists*, *path-using cyclists*, *fairweather utilitarianists*, *leisure cyclists*. The *dedicated cyclists* are motivated by speed, predictiveness and flexibility, identify strongly with cycling and are not influenced by weather conditions. The *path-using cyclists* are very much alike dedicated cyclists, but differ in that they prefer separate cycle lanes instead of sharing the road with cars. The *fairweather utilitarianists* use their bicycle when the circumstances make it the easiest mode for their trip. The *leisure cyclists* cycle as their hobby or joyful activity in itself. Furthermore, they prefer separate cycle infrastructure. The distinctiveness of the four cyclist types, based on many characteristics, allows policy interventions to target specific groups.

To conclude, travel behavior, sociodemographic variables and attitudes are all factors that are considered, both separately and in combination, among research that has proposed typologies of cyclist groups. All segmentation approaches have their pros and cons with regards to the insights they provide for the development of policy interventions. Besides the importance of understanding who cycles and thus may use the Dutch cycle highways, it is also important to look

into the way cycling is actually experienced. The next section will therefore explore the academic literature on cycling experiences.

2.3 Cycling Experiences

Cyclists and their experiences are unique and cannot be regarded as similar to either motorized vehicles or pedestrians (Hamilton-Baillie, 2004). The importance of considering the cyclist's perspective becomes evident from Forsyth and Krizek's (2011) study. They analyzed whether auto-oriented design strategies also work for cyclists or if reconceptualization of urban design is needed when considering the needs of cyclists. By examining common approaches to designing infrastructure and surrounding buildings and landscapes, Forsyth and Krizek (2011) conclude that the experience of cycling should be considered more in urban design. Whereas cycling infrastructure so far mainly focuses on safety, convenient facilities and complete networks, the cyclist's experience of the environment should be given a more central place. By acknowledging the distinct viewpoint and needs of cyclists in the design, it is argued to be more likely to increase cycling as physical activity than almost exclusively focusing on functional design issues (Forsyth & Krizek, 2011). Furthermore, Liu et al. (2018) emphasize the role of urban designers and practitioners in creating cycling infrastructure that considers cycling experiences. This is because cycling is essentially the relationship between the cyclists and the environment, which is mediated by movement (Liu et al., 2018). Understanding cycling experience is therefore crucial. Through a systematic literature review of twenty empirical papers, Liu et al. (2018) evaluated textual, visual and evaluative methodologies that were used to obtain insights on cycling experiences. In doing so, Liu et al. (2018) conceptualized cycling experience as a social, spatial and sensory phenomenon.

Social Experience

The social experience is mainly about the cyclist's interaction with other people on the street, the normality and image of cycling in general, the participation in the traffic system and perception of freedom of movement (Liu et al., 2018). This social experience is often captured by qualitative methods in which cyclists are open to express their feelings. Through extensive interviews McCarthy (2011) found that cyclists in Charleston, South Carolina feel socially marginalized. Cyclists identified risky behaviors of motorized traffic which they perceived to be part of an anti-bicycle culture. In this culture car drivers appear to be dominant road users and cyclists and excluded from the road (McCarthy, 2011). The study also shows that the social experience of cycling is very dependent on the national and even local norms, values and culture.

Sensory Experience

The sensory experience includes environmental perceptions such as smells, noise and weather, as well as personal perceptions such as the feel of one's bicycle, carrying baggage or feeling unskilled or unsafe. Liu et al. (2018) explain that Middleton's (2010) observation of "equipmentality" of walking can also be applied to cycling research. Middleton (2010) argues that humans, objects and the environment should be combined instead of viewing them as separate entities. In the example of walking, Middleton (2010) gives the example of human-socks-shoes-pavement entity that influences the walking experience of a person called Paul: "the tightness of Paul's shoes 'intervene' or 'disrupt' the 'flow' between Paul's body and the pavement upon he walks" (Middleton, 2010, p.588). When translated to the cycling context, the quality and type of bicycle can also be important factors in explaining the experience of disruption and flow (Liu et al., 2018). "Just as walking feels different when pushing a stroller or when carrying a heavy backpack, cycling

can feel different depending on the weight of the bike and the mounting of luggage" (Liu et al., 2018, p. 102). Middleton (2010) also points out that there are different styles of walking, which can also be translated to cycling as there are commuting cyclists but also recreational cyclists that closely link to the bodily senses and sense of place (Liu, et al., 2018).

Another studied factor that links to the sensory experience of cycling is weather conditions. Böcker, Dijst, Faber and Helbich (2015, p.136) conclude that "being more intensively and intimately connected to their physical surroundings while travelling, active mode users have overall more positive en-route place valuations than public transport and especially car users". However, they also conclude that this intimate connection also has its backside when the weather is cold, wet and windy. One method that can reveal aspects of unquantifiable sense and feeling is the ride-along method (Liu et al., 2018). Here, the researcher cycles with the research participant and asks questions, listens and observes the participants while recording using audio, video and GPS. Van Duppen and Spierings (2013) applied this method when studying sensory landscapes between home and work in Utrecht. They found that people described their sensory experiences in terms of noise, traffic, weather, architecture, mental focus, rhythm and chaos. However, the same physical sensation can be perceived and experienced differently depending on one's personal history. This is because the interpretation of cycling environments are related to personal preferences, intentions and memories (Liu et al., 2018).

Spatial Experience

The spatial experience is about the perception of the space in the larger environment. It includes tangible elements such as landmarks, wayfinding and affordances, but also one's spatial identity and relationship to the place (Liu et al., 2018). Spatial experience of cycling is a fundamental consideration in spatial design that focuses on providing high-quality environments rather than just accommodating traffic. Research that has tried to uncover the spatial experience of cycling often employs evaluative methods such as cognitive work analysis and visioning (Liu et al., 2018). In relating space to aspects of experience, Böcker et al. (2015) found that cyclists' exposure to weather conditions asks for climate sensitive planning in the transport sector as well. By implementing deciduous trees, precipitation shelters and wind barriers along cycling infrastructure could enhance livability and usage of these spaces (Böcker et al., 2015).

The study by Manton, Rau, Fahy, Sheahan and Clifford (2016) used mental mapping to define infrastructural characteristics for which cyclists have negative perceptions of safety. The rather dominant technical cycling guidelines capture only the objective cycling environment. Whereas the cyclist's personal spatial experience of safety tells policy makers what, where and why the cyclist feels safe and welcome. Hence, it can inform policy makers on why certain cycle infrastructure may or may not be used. In a broader sense, tangible spatial elements such as architecture and landmarks also play an important role in a cyclist's spatial experience. Van Duppen and Spierings (2013) found that commuting cyclists viewed bridges, canals and buildings as key aspects of their cycling experience. More specifically, a yellow bridge in Utrecht brought about strong positive responses among cyclists as they found it 'beautiful', 'magnificent' and 'really cool'.

Travel Time

Even though Liu et al. (2018) provide a clear conceptualization of what cycling experience may entail, they also recognize that the experience of time while cycling is missing from their review.

It should be noted that the experience of travel time may be of more importance to cyclists on directed travel trips than cyclists on undirected travel trips. Several studies on travel time have found a discrepancy between the actual and the perceived duration of travel time (Tenenboim & Shiftan, 2018; Delclòs-Alió, Marquet & Miralles-Guasch, 2017). The assimilation-contract theory can explain why in certain cases people may perceive time going more slowly than it actually is. The theory states that a discrepancy between the expected and experienced duration will incline people to overestimate the duration of time (Van Hagen, 2011). This situation is likely to happen when environmental stimuli are low and people get bored (Olde Kalter & Groenendijk, 2018). The stress management theory on the other hand posits that people under physical or emotional stress will experience any duration as longer than it actually is. If people know about the expected duration it will lower his or her stress levels and consequently affect one's perceived duration of travel time as shorter (Van Hagen, 2011). According to Olde Kalter and Groenendijk (2018) these two theories translate to the following hypothesis about cycling experiences: "when people cycle alongside a boring, monotone route, the brains receive too little stimuli which leads to a feeling of boredom and longer perceived duration of travel time" (p.6). On the other hand: "when people cycle alongside a busy, chaotic and noisy route, the brains receive too many stimuli which leads to stress and longer perceived duration of travel time" (Olde Kalter & Groenendijk, 2018, p.6). Therefore, the optimal cycling route would be an attractive and diverse one which gives enough stimuli to the brains so that the route is experienced shorter than the actual travel duration. The study by Olde Kalter and Groenendijk (2018) confirmed this expectation by showing that cyclists experienced attractive routes as shorter in time than less attractive routes.

Both Olde Kalter and Groenendijk's (2018) study and the review of Liu et al. (2018) showcase the importance of considering the cyclist's experience in designing cycle infrastructure that stimulates cycling. Nevertheless, transport research generally lacks attention to these embodied and sensory aspects of mobility. Instead, transport research focuses on travel time as a cost of moving from A to B (Spinney, 2009). This principle is dominant in the conventional transport paradigm, whereas the sustainable mobility paradigm views cyclists, and their experiences, differently. The differences between the two paradigms and design logics that follow from them, will be reviewed in the next section.

2.4 Design Logics: a practitioner's rationality

"Mobilities do not just happen or simply take place. Mobilities are carefully and meticulously designed, planned and 'staged' from above. However, they are equally importantly acted out, performed and lived as people are 'staging themselves' from below." (Jensen, 2013, p.4). From Jensen's perspective it becomes clear that mobilities emerge from the interaction between staging and being staged (Figure 1). As a starting point, Jensen (2013) explains that practitioners design the infrastructural scenes that can host everyday-life mobilities. Therefore, practitioners play a key role in setting the stage for all kinds of mobilities. Different from the definition of design as a product that refers to the plan from which the cycle highway is constructed, practitioners are involved in the process of designing. De Jonge (2009) defines designing as "forethought in making" (p.28). As such it is a distinctive mental activity that precedes the eventual cycle highway design guiding the construction.

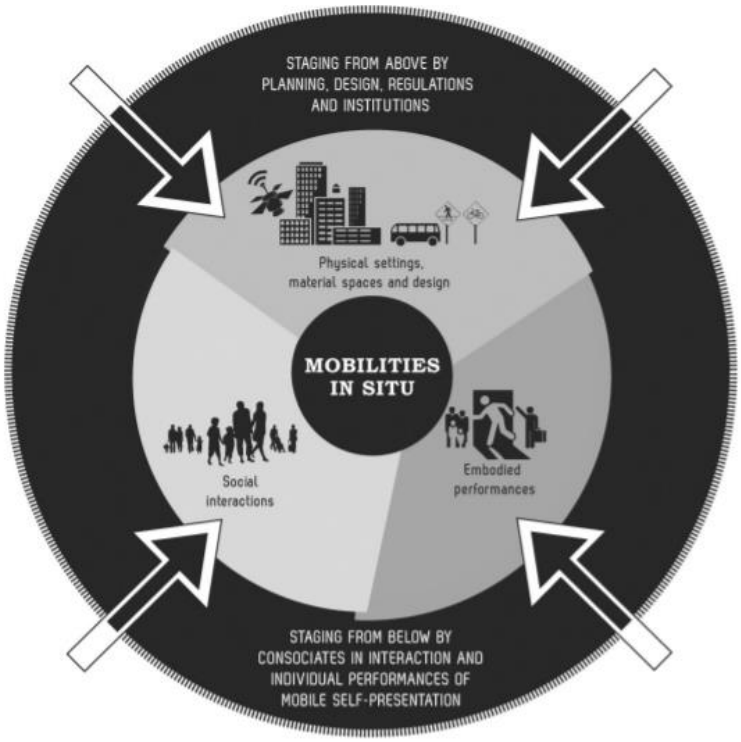

Figure 1. Staging mobilities model. Reprinted from *Staging Mobilities* (p.6), by O. B. Jensen, 2013, London, England: Routledge.

When looking closer to the reasoning and decision-making process in designing infrastructural scenes, rationality plays a key role. Rationality is "meant to logically frame intentional behavior and the ensuing course of action in a given situation, supported by existing knowledge, information and experience, and often based on an underlying paradigm" (De Roo & Perrone, 2020, p.35). In other words, rationality is a frame of reference and a product of the reasoning mind that guides responses and decisions. It informs us about how the world around us works, given a particular perspective or paradigm, and how to act accordingly, which influences choices and decision making (De Roo & Perrone, 2020).

According to De Roo (2016) there are two main 'extremes' of rationalities: technical rationality and communicative rationality. A technical rationality is based on object orientation, the observation of facts and causal linear relationships. Whereas a communicative rationality frames the world based on the agreement between individuals reached through free and open discourse, recognizing fuzziness and unpredictability (Allmendinger, 2017). Even though these two basic rationalities are rather abstract, they have informed concrete approaches in planning. In the transport planning debate, two main paradigms can be identified. Each in line with certain guiding principles from either technical rationality or communicative rationality. These main paradigms and their contrasting ideas on how mobilities ought to be staged are elaborated upon in the next section.

Two paradigms

The conventional transport paradigm of transport planning strongly reflects a car-based rationality. This may not come as a surprise given the popularity of the car in the past century. Like Banister (2005) states: "if there is one object that has become an icon of the twentieth century, it is the car and it is difficult to see how that will ever change" (p.5). The car stands for

individuality, convenience, flexibility and freedom. However, the car is also socially and spatially divisive as it allows cities to spread and people to travel further (Urry, 2001). It has made space something you want to pass through rather than to stop in. These developments are strongly reflected in the conventional transport paradigm of transport planning. More specifically, it puts the car, and motorized traffic more broadly, central in transport planning. In this it values speeding up traffic, minimizing travel times and providing infrastructural solutions by predicting and forecasting traffic (Banister, 2008). Thereby focusing on the issues of utility, efficiency and economic growth (Kębłowski, Dobruszkes, & Boussauw, 2020). As such the conventional transport paradigm is a rather technical rational approach to transport planning (Vigar, 2017). However, it has also been argued that the conventional transport approach underestimates the key challenges facing urban planners, encouraging an alternative paradigm to arise (Banister, 2008).

More specifically, the downsides to car consumption have become more evident. Even though individuals perceive great benefits from its use, it also comes with costs for others, both directly through air pollution and indirectly through congestion and accessibility issues (Banister, 2005). In response, there is a growing consensus that active mobility modes such as cycling should be stimulated as they positively impact social and ecological sustainability. In line with this, many cities and urban regions have articulated ambitious cycling policies to stimulate this modal choice (Te Brömmelstroet et al., 2020). However, as Banister (2008) argues, the existing conventional transport paradigm, guiding transport oriented developments, ought to be adjusted as well if the sustainable mobility agenda is to become a reality.

According to Banister (2008) there are two principles embedded within the conventional transport paradigm that are worrisome. First, travel is seen as a derived demand rather than a valued activity. In other words, the journey is not of importance, only the destination is. Second, people are assumed to minimize their travel costs and time. This means the modal choice will be informed by the fastest and cheapest option. Based on these two principles, transport planning has contributed to car dependence and decentralization of cities. More specifically, the growth in faster and longer travel have outweighed the benefits of local public transport, walking and cycling, as travel time has remained constant (Deakin, 2006; Banister, 2005; 2008; Duranton, 2006; Kahn, 2006). In response to this conventional transport paradigm, Banister (2008) introduced the sustainable mobility paradigm (Table 1 for an overview of characteristics). Guided by optimal links between land use and transport, cities ought to be designed so that people would not necessarily need to have a car. In line with the sustainable mobility agenda, many Dutch regions have invested in the development of cycle highways. As the current study seeks to explore the logic behind cycle highways, both the conventional transport and sustainable mobility paradigm are to be examined and compared. The differences between the paradigms inform the different logics that may underlie the design of cycle highways. Two differences between the paradigms that are fundamental in designing cycle highways are ‘travel as derived demand versus valued activity’ and ‘traffic focus versus people focus’. These will therefore be examined in more depth below.

Table 1

Conventional transport paradigm	Sustainable mobility paradigm
Physical dimensions	Social dimensions
Mobility	Accessibility
Traffic focus, particularly on the car	People focus, either in (or on) a vehicle or on foot
Large in scale	Local in scale
Street as a road	Street as a space
Motorized transport	All modes of transport often in a hierarchy with pedestrians and cyclists at the top and car users at the bottom
Forecasting traffic	Visioning on cities
Economic evaluation	Multicriteria analysis to take account of environmental and social issues
Travel as a derived demand	Travel as a valued activity as well as a derived demand
Demand based	Management based
Speeding up traffic	Slowing movement down
Travel time minimization	Reasonable travel times and travel time reliability
Segregation of people and traffic	Integration of people and traffic

Note. Adapted from *Planning for a Sustainable Future* (p.140), by S. Marshall, 2001, London, England: Spon. And reprinted from "The sustainable mobility paradigm", by D. Banister, 2008, *Transport Policy, 15*(2), 73-80.

Transport as Derived Demand vs Valued Activity

The conventional transport approach assumes that travel is a cost, a derived demand and therefore travel times should be as short as possible (Banister, 2008). Several scholars have contested this conventional wisdom and suggest that travel can also be a valued activity. Mokhtarian and Salomon (2001) explored the phenomenon of undirected travel, which is "movement through space for which the destination rather than the travel is ancillary" (Mokhtarian & Salomon, 2001, p.698). Most undirected travel is leisure travel. According to the escape theory hypothesis a substantial share of leisure travel takes place because the activity of travelling itself is valued. The theory proposes that leisure travel is a form of compensation for a declining quality of life (Heinze, 2000). Through leisure travel people seek to get away, or escape, from their daily environment (Banister, 2008). This implies that the activity of travelling is actually valued in such cases. There are certain intrinsic aspects to travel that contribute to a perceived positive utility, like the sensation of speed, exposure to the environment and enjoyment of the scenic beauty of a route instead of just a destination. It is likely that these same positive aspects of travel may to some extent also apply to directed travel (Mokhtarian & Salomon, 2001).

One form of directed travel is daily commutes. With regards to such daily commutes, Bahrami and Rigal (2017) researched the notion of effort regarding active mobility. Looking at the increasing value of physical effort in urban lifestyles, they challenged the conventional transport approach that assumes a negative experience of effort. This negative experience of effort is twofold: least effort and distracted effort. The principle of least effort assumes people tend to minimize their mental and physical effort regarding their mobility behavior. Distracting effort builds upon the negative experience of effort by focusing on distracting the individual from having to put in effort. Lavadinho and Winkin (2009) for instance proposed that providing affordances and distractions in urban spaces could make inhabitants go for longer walks 'without realizing it'. However, next to the negative experience of effort, there can also be a positive experience of effort. Bahrami and Rigal (2017) introduced the idea of entraining effort. Here, effort is seen as a rewarding and stimulating experience. Their results show that people value the perceived well-being and physical fitness that results from their active daily commutes. The experience of entraining effort matches the perception of transport as a valued activity. Whereas viewing active mobility and its effort negatively implies seeing transport as a derived demand.

When translated to the case of cycle highways, the conventional transport approach would assume people choose to cycle when the cycling route is faster than the journey by car. Following this rationale, the most straight and efficient route would therefore trigger people to use the cycle highway. On the other hand, the sustainable mobility paradigm and related studies suggest a different logic. Namely, a preference for a cycle route that may take more time and effort, but is perhaps more attractive. Since effort can be positive and stimulating and the journey contains intrinsic aspects that are valued, it would trigger people to use the cycle highway.

The Physical vs the Social Dimension

Another fundamental difference between the conventional transport paradigm and the sustainable mobility paradigm is the focus on the physical dimension versus the social dimension (Banister, 2008). This is in line with what Hamilton-Baillie (2004) calls the traffic zone and the public realm. Traffic zones have basically one purpose: the movement of traffic. These zones, such as highways, are guided by rules, regulations, examination and legal enforcement. It makes the system rather predictable, impersonal and uniform (Hamilton-Baillie, 2004). On the other hand, there is the so-called public realm. In these spaces, the movement of traffic is only one of a range of activities. The diversity of functions and personal and culturally defined interactions makes these systems complex and unpredictable (Hamilton-Baillie, 2004). Te Brömmelstroet et al. (2020) refers to the two dimensions as the street and the sidewalk. Here, the curb is the physical boundary separating people who walk from the people who drive. It also represents the boundary between the logic of walking and the logic of driving. Furthermore, and more literally, it divides the slow from the fast, the motorized from the human-powered and the enclosed vehicles from the exposed people (Te Brömmelstroet et al., 2020). Several academics have questioned where cycling fits in between the two realms (e.g. Latham & Wood, 2015; Liu et al., 2018; Nello-Deakin, 2019). Liu et al. (2018) argue that given the relative slower speed of cycling and one's direct exposure to the environment, cycling may fit better with urban design literature on walking. However, one could also consider cyclists and their experiences as unique from both dimensions.

As mentioned, Forsyth and Krizek (2011) argue that the cyclist's perspective is unique compared to motorized traffic and pedestrians. In line with this argument, Liu et al. (2018) tried to uncover

the cyclist's experience by identifying distinctive social, sensory and spatial elements to it. Both studies inform us that a focus on either the traffic zone or social realm in planning for cycle highways would be too simplistic. A careful consideration of the unique characteristics of cyclists and optimal rider experience is important in ensuring that cycle highways are used and that the user benefits from the investment (Millar et al., 2021).

Reflecting back, the two paradigms addressed by Banister (2008) add to the staging mobilities model by Jensen (2013). More precisely, the design of cycle highways can also be staged from above by the dominant paradigm that is reflected in the practitioner's perspective. With regards to the differences between the conventional transport paradigm and the sustainability paradigm, the following can be concluded. A conventional transport design logic follows a technical rationality in which speed, efficiency and utility are guiding. Thereby, not necessarily considering the unique perspectives of various cyclist types and their unique experiences. A sustainable mobility design logic follows a more communicative rationality in which the activity and the experience are guiding. Hereby, valuing the unique perspectives of the cyclists. Thus, both paradigms or logics could explain how practitioners think about the users, their experiences and consequently consider this in designing cycle highways. However, these logics may not be the only factor that could influence the eventual design of cycle highways. Both Liu et al. (2019) and Te Brömmelstroet et al. (2020) have found that institutional requirements and funding mechanisms limit the extent to which European practitioners can deviate from strict engineering guidelines. The next chapter will explore this by elaborating on the Dutch institutional context.

2.5 Towards a Conceptual Model

The literature review above has critically explored the concepts included in the current study and the way they possibly relate to one another. In short, a clear unified definition on the concept of cycle highways is still lacking. However, to ensure cycle highways are used to its fullest potential, academics have argued that cyclist types and their experiences should be considered. There are many typologies of cyclist types that focus on various factors such as travel behavior, sociodemographic characteristics or attitudes. They all stress that different cyclist types have different needs and experiences. A recent conceptualization of cycling experiences explains it as distinctive social, sensory and spatial experiences. Based on multiple studies, the subjective experience of travel time was added to this conceptualization. Academic literature clearly points to the importance of considering cyclist types and experiences when making cycling policies and creating cycling infrastructure. Nevertheless, a closer look into the known paradigms behind infrastructural planning showcases contradicting considerations of these users. In brief, the conventional transport paradigm focuses on traffic whereas the sustainable mobility paradigm focuses on its users. As stated by Jensen and his staging mobilities perspective, practitioners play an important role in creating the infrastructural scenes that host mobilities. Informed by these contrasting paradigms, referred to as design logics, the cyclist perspective may be considered differently by the practitioner in the design of cycle highways.

In sum, the critical review on the relevant academic literature proposes the following conceptual model (Figure 2). Cycle highways are staged from above, by the practitioner's design logic that influences the eventual design of the cycle highway. However, cyclists also have their unique view on what this design of the cycle highway should entail. Based on the type of cyclists and their

experiences, these users stage mobilities from below. The cyclist's perspective, with its types and experiences, can be considered by the practitioner in the design of cycle highways.

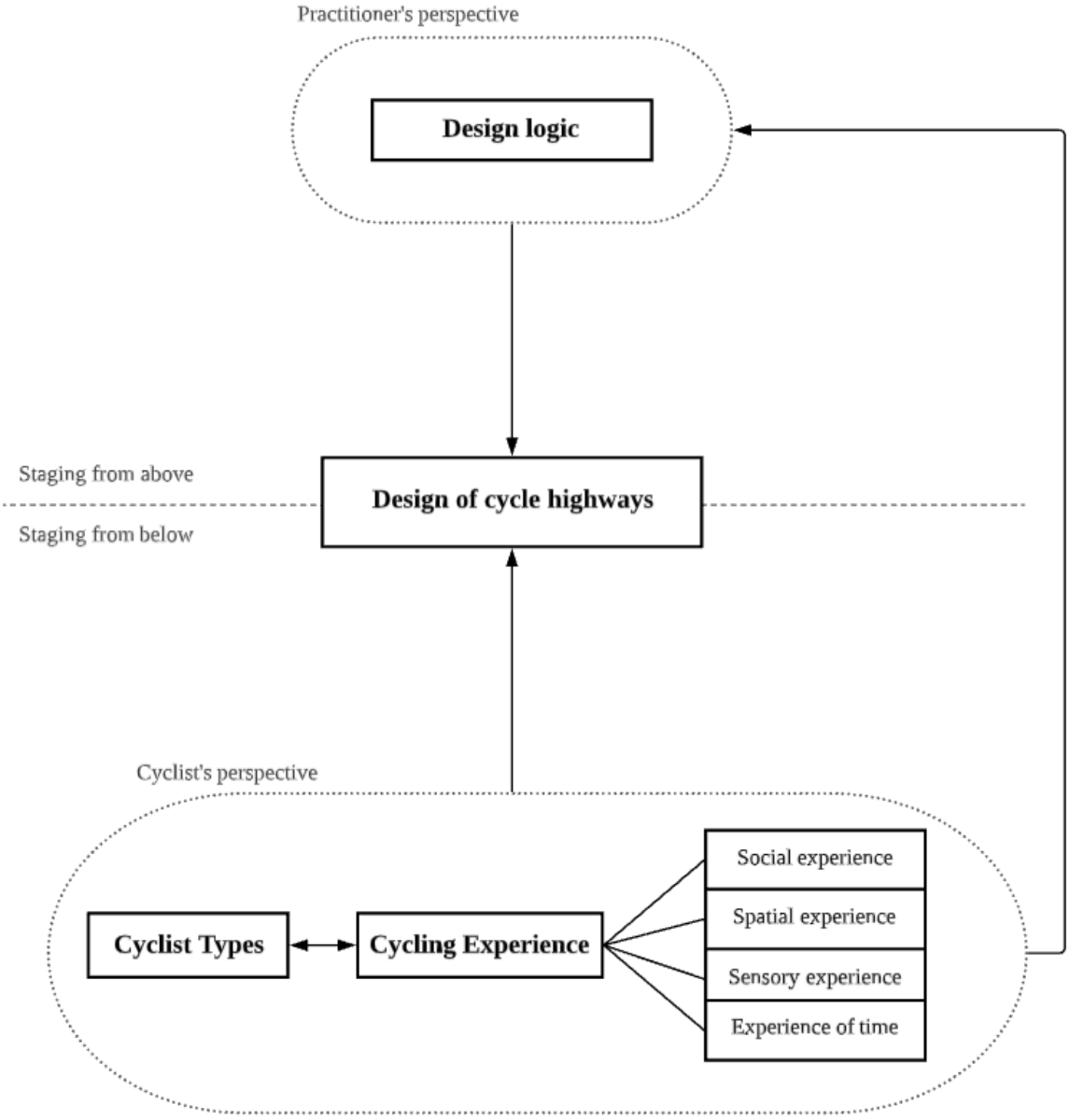

Figure 2. Conceptual model

3. Institutional Factors

As mentioned, dominant design logics that practitioners tend to follow may not be the only factor that could influence the design of cycle highways. The study by Liu et al. (2019) showed that institutional factors can push the design of cycling infrastructure to adhere to strict engineering standards. In general, institutions are "the formal rule set or rules of the game" (Canitez, 2020, p.2) and include both formal and informal factors. Considering the staging from above perspective that is applied in this study, the focus will be on formal institutional factors. According to Canitez (2020) these broadly refer to laws, regulations and policies. Based on the findings by Liu et al. (2019) and the proposed model by Jensen (2013), this chapter will specifically explore design guidelines, funding mechanisms and involved actors in the Dutch cycle highway context. In doing so, it will first touch upon the background of the concept in the Netherlands.

3.1 Background of Dutch Cycle Highways

In the 1970's the Netherlands was the first to experiment with the cycle highway concept with routes between Tilburg and The Hague. However, modern designs have been explored since 2002 (Ter Avest, 2015). It was the national program 'FileProof' from the ministry of Traffic and Water in 2006 that included the project called 'Fiets filevrij!' which is Dutch for cycle congestion free. The project aimed to stimulate car-oriented commuters who lived within 15 kilometers from their work to choose the bicycle as mode of transport. The behind-lying goal was the reduction of traffic congestion in rush hours (Ter Avest, 2015). The process oriented collaboration between the ministry, de Fietsersbond and decentral governments has realized around 500 kilometers of cycle highways from 2006 to 2019. Their ambition is to realize another 800 kilometers of cycle highways in the near future (Schlijper, 2019).

As previously mentioned, the first Dutch cycle highways were initiated by a governmental incentive to reduce traffic congestion. The first generation of cycle highways were therefore located close to these congestion junctions (Fiets Filevrij, 2015). Since 2013 decentralized governments have taken initiatives to develop and realize new cycle highways regionally. A broad movement emerged which became evident from the initiative 'Tour de Force' in 2015. Together the CROW/Fietsberaad and the (de)central governments have created a widely supported agenda of important societal themes that need to be addressed to stimulate cycling in the upcoming years. The agenda shows that cycle highways are no longer just a traffic-oriented development. By developing a national network of cycle highways, all regions can benefit from the positive effects on accessibility, health, spatial quality and the economy (Fiets Filevrij, 2015).

First, a national network of cycle highways can increase accessibility. In combination with public transport services, cycling can become a faster mode of transport in comparison to the car. Especially due to digitization and growing information services, multi-modal travels have become more efficient. Second, cycling is beneficial for people's health. Even though this is not a new fact, a certain 'health trend' has emerged in the past decade. By means of apps and campaigns commuters have been pushed to choose other travel modes than the car. Next to the individual health benefits, it also results in a cleaner environment for all. Third, sustainable development has risen to the top of many city agenda's. Spatial quality and clean air are important determinants for spatial quality, which are influenced by the modal choice of the residents. Fourth and last, healthy employees, accessible work locations and attractive residential environments increase the

economic vitality of city regions. Hence, the bicycle plays an important indirect role for the economy. In sum, cycle highways of today seem to be focused on providing benefits for numerous societal issues.

The planning of cycle highways is roughly structured around four sequential phases: preparatory phase, exploratory phase, development phase and realization phase (Venema, 2019). The project organization Fiets Filevrij has monitored the planning processes of former cycle highways in the Netherlands. Based on these experiences they presented a process guide on planning cycle highways in 2009. The seven steps are still relevant today and being used in current projects. A detailed description of the seven steps is provided in Appendix A. In some instances the sequence of steps deviates. Nevertheless, the seven steps generally include:

1. Exploration and start-up
2. Inventory of routes
3. Intention declaration
4. Elaboration cycle highway route
5. Signing general governance agreement or covenant
6. Realization
7. Opening

3.2 Design Guidelines

With the rise of cycle highways, the need for design guidelines and recognizability arose as well. Since 2014 the Dutch independent knowledge platform CROW provides an inspirational guiding manual for the design of cycle highways in the Netherlands. The updated version of 2016 includes a definition for the cycle highway, stating "the term used for high-quality regional cycle routes which main purpose is to facilitate journeys by bicycle over distances from 5 to 30 km" (CROW, 2016; Kristjansdóttir & Sjöö, 2017, p.7). The manual provides five guiding principles for a cycle-friendly infrastructure and cycle highways:

Cohesion The infrastructure should have a high level of continuity so that the cyclist is able to reach the destination seamlessly (Venema, 2019). Cycle highways are fundamental for commuters possibilities within the region. They contribute to practical and recreational levels of service as a connection between city and country (Kristjansdóttir & Sjöö, 2017).

Directness The infrastructure should provide a route that is as short as possible without detours. This way the bicycle can be preferred over the car as a modal choice for commuters (CROW, 2006; Venema, 2019). The detour factor on a route should not exceed 1.2. (Kristjansdóttir & Sjöö, 2017).

Attractiveness The infrastructure should be designed and blended with the natural surroundings such that it attracts cyclists to take the route. However, attractiveness is a highly subjective principle that may be differently perceived by cyclists (CROW, 2006; Venema, 2019).

Safety The infrastructure should guarantee the traffic safety of cyclists and other road users (CROW, 2006; Venema, 2019). It includes sufficient skid-

resistance, good ride quality, minimal nuisance from fellow route-users and safety at junctions and bicycle crossings (Kristjansdóttir & Sjöö, 2017).

Comfort The infrastructure should enable safe and smooth over-taking, providing a quick and comfortable flow of cyclists (Kristjansdóttir & Sjöö, 2017). Any nuisance and delay from A to B should be minimized (CROW, 2006; Venema, 2019).

The Dutch guidelines have become internationally recognized, as also by the European Commission Mobility and Transport (ECMT). The ECMT has recommended Member States to take the guiding principles by CROW as complementary standards. With that, the ECMT also recognizes that some of these principles may conflict with one another. Inevitably leading to prioritization of certain principles. Regardless of whether the cycle infrastructure is considered to be utility or recreational, safety should always be the number one priority (ECMT, 2021).

3.3 Involved Actors

Cycle highways cross many administrative boundaries and therefore involve many parties in the development of the project. Every municipality in the Netherlands is in charge of developing their own structural vision by the Act spatial planning (Wet ruimtelijke ordening). Furthermore, projects or sectoral visions can be elaborated upon in the part structure vision. The provinces and national government are also obliged to develop a regional (provinces) or national (government) vision(s) on their territory. The visions also set course for mobility related issues and goals such as the development of cycle highways. Since cycle highways often physically cross multiple municipalities, it requires alignment between the province and municipalities. Here, provinces often provide the overarching vision and means to lead such projects. The project team of cycle highways generally include practitioners from the province and involved municipalities. These practitioners can have varying professional roles within their organization such as planners, advisors or policy makers within the mobility domain. The municipalities have more detailed information about the opportunities for the types of use and spatial development in their area, written in the zoning plan (bestemmingsplan). In case a desired route of a future cycle highway crosses for instance a nature area, the zoning plan indicates which requirements and legal steps need to be taken for the project to continue or be adjusted. A zoning plan is also subject to elaboration or adjustment depending on the type of plan (Kenniscentrum InfoMil, 2021). Together, the representatives of the province and municipalities are to collaboratively explore, develop and deliver a set of sketch designs including cost estimates. The eventual decision on proceeding and route choice lies at the councils of the involved municipalities and province (Clean Tech Regio, 2021a). Hence, the practitioner's perspective in this study refers to the project members of the province or municipalities that are involved in developing the design of the cycle highway.

Next to governmental bodies, there are also non-governmental bodies involved in the design of cycle highways. Oftentimes research on the potential trajectories is outsourced to advisory companies. These evaluate the options based on the set criteria by the project group which often includes members from the province and municipalities. Next to governmental and non-governmental organizations, the design of cycle highways also concerns local residents. Through real life or online sessions, stakeholders are often asked to participate and share their point of view regarding the trajectory options or the development of a cycle highway in general.

Participation sessions can be organized by the project team or outsourced to a communication and participation advisory organization (SIR, 2021).

3.4 Funding

The province and municipalities do not only take part in developing visions, zoning plans and designing the cycle highways, but also in financing the project. In general, the regional cycling connection is subject to the finances of the region (municipalities and province). However, the national government also has an interest in high quality regional cycling paths that benefit health, economic accessibility, the environment and reduce traffic congestion. Therefore, the national governments provide funds for projects that add to the national agenda on the future of cycling. In the past such similar funds have provided subsidies to cycle highway projects that cover half of the costs. The other half of the costs is to be financed by the region. The exact division is agreed upon when signing the governance agreement (Clean Tech Regio, 2021a). Besides the governmental funds that often cover the majority or full costs of the project, there can also be private funds available. Private funds may come from the Dutch national railway, project agencies, estates and investors (Regio Twente, 2014).

As mentioned, many finished cycle highway projects have partially been subsidized through funds from the national government. One of these funds is the Dutch mobility fund that was established as part of the Multiple year program Infrastructure, Space and Transport (MIRT). Another fund is the Broad Goals subsidy Traffic and Transport (BDU). This fund for instance finances 50% of the realization costs of the F35 trajectories to assure the cycle highway is of the highest quality standards. However, in order for Twentse municipalities to apply for the co-funding of F35 trajectories, the Regio Twente sets certain requirements. In case of the F35 these specified requirements are based on the design principles directness, cohesion, comfort and safety (Regio Twente, 2014). According to Liu et al. (2019), funding functions as a bridge between policy and design. The set visions and goals that are mentioned in policy documents are translated into certain design guidelines by the CROW in design manuals. In spanning policy and design, regional and national funding schemes define what types of infrastructure qualify for these funds. Hence, they often require adherence to the suggested design guidelines for cycle highway projects that have certain visions and goals that match national cycling ambitions.

To conclude, Dutch cycle highways were initially developed to reduce traffic congestion but have grown into a cycling innovation that could provide benefits for multiple societal issues. The CROW has developed five leading design principles for cycle highways that are guiding for projects nationally and internationally. In the design process governmental and non-governmental actors are present that can have various interests and influences on the design. The project team includes practitioners from the province and municipalities that collaboratively develop a design. Most funding is provided by governmental bodies and often supplemented with subsidies from national or regional funds. These subsidies often set certain quality requirements that a project needs to meet in order to apply for it. Having explored these specific institutional factors in the Dutch context, the conceptual model is adjusted to incorporate these (Figure 3).

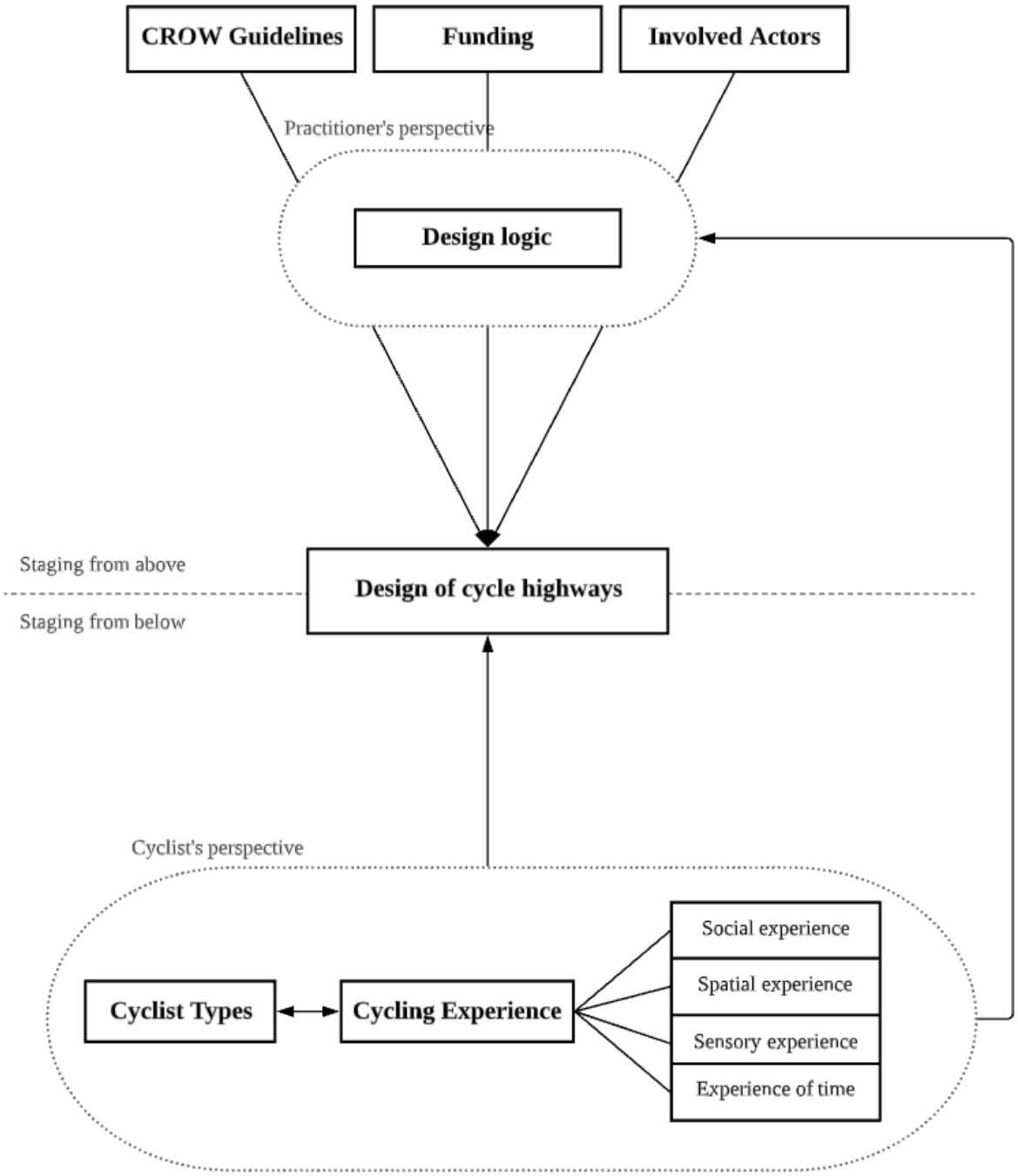

Figure 3. Adjusted conceptual model

4. Methods

This chapter discusses the methodological choices that were made in this study. First, it elaborates on the research design followed by a description and explanation of the cases selected. Thereafter, it touches upon the data collection and data analysis techniques that were employed. Lastly, the chapter discusses the ethical considerations within this research.

4.1 Research Design

This study aims to explore to what extent and how different cyclist types and cyclist experiences are considered in the design of cycle highways in the Netherlands. In order to provide an in-depth and interpreted understanding of these design considerations, a qualitative research approach is suitable. Qualitative research is an approach concerned with exploring phenomena while taking the perspectives and accounts of research participants as a starting point (Ritchie, Lewis, McNaughton Nicholls & Ormston, 2014). This study takes the perspective of the practitioner to explore how they stage mobilities through dominant design logics and see the influence of other institutional factors.

Furthermore, a multiple case study research is employed. Multiple case studies enable the exploration of multiple perspectives which are rooted in a number of specific contexts (Ritchie et al., 2014). As this study seeks to uncover the design logic behind the Dutch cycle highways in general, multiple cases in different regions in the Netherlands were included. Moreover, the integration of different perspectives aids an holistic, in-depth and contextualized understanding of the phenomena under research (Ritchie et al., 2014).

4.2 Case Selection

This study involved three cycle highway trajectories in the Netherlands (Table 3). To select the trajectories, a purposive sampling strategy was used as sampling method. Cases have been selected non-randomly using a set of predefined criteria (Table 2).

Table 2

Case selection criteria	
1	All cases are *located within the Netherlands*, to meet this study's objective to provide insights on the rationale of Dutch cycle highways.
2	All cases *were (partially) still in the exploration phase during 2020,* so that it provided insights on the most recent design logics and influencing institutional factors.
3	All cases are trajectories of a *distance exceeding 5.0 kilometers*, to meet the definition of cycle highway used in this study.
4	All cases are trajectories that *connect cities and/or towns*, to meet the definition of cycle highway used in this study.
5	All cases have *sufficient documents available* regarding the goals and design considerations.

Table 3

	Cycle route	Project phase	Connection	Province	Length
	F35 Almelo - Borne	Exploration phase in which one preferred route and its design is elaborated upon	Almelo – Borne	Overijssel	10km
	Doorfietsroute IJsselstein – Utrecht	Development phase in which the route is set, but the definite design is still being developed	IJsselstein – Nieuwegein – Utrecht	Utrecht	12km
	F50	Exploration phase in which two scenarios and their designs are elaborated upon	Apeldoorn – Epe	Gelderland	13km

F35 Almelo – Borne

The F35 is a cycle highway that connects Enschede with Hengelo, Almelo and Nijverdal. The masterplan of the 62 kilometers long cycle highway was set in 2009 and adjusted in 2014. However, the exploration on route option for the trajectory between Almelo and Borne has been investigated recently, in 2019. Goudappel Coffeng explored several route options and proposed one preferable route to the province and municipalities. The provisional design was discussed with stakeholders in 2020 and adjusted accordingly. The design was planned to be finalized in 2021 after which the project would enter the realization phase. Due to financial shortages and varying opinions among municipalities on the preferred trajectory option, the project progress is currently on hold.

Doorfietsroute IJsselstein – Utrecht

In March 2019 the province of Utrecht and municipalities of IJsselstein and Nieuwegein signed the Intention Declaration to work on a'doorfietsroute'. In this case, the exploration phase of potential routes started afterwards. In November 2019, residents of the Paardenlaan in IJsselstein and other stakeholders were invited to participate in a design session, resulting in several route options. In March 2020 residents and employees in IJsselstein were asked to indicate their preferred route choice. Based on the input of 551 people and a variant study, the municipality of IJsselstein has chosen to further elaborate on the Baronieweg route. The first provisional design was shared in January 2021 with local residents of whom 69 gave their feedback. On the 12th of July 2021 the collaboration agreement was signed, which marks the start of the realization phase.

F50

The F50 is called a fast cycle route that connects Apeldoorn with Epe. The Cleantech Regio[1] has started preparing and exploring possible routes in 2016/2017. In 2019, two potential routes were further developed into sketch designs. A lot of research has been conducted to examine what the bottlenecks of both options are and how they relate to the areas' ecology, culture and landscape history, among others. In February and March of 2020 the residents and potential users of the cycle highway were asked to review the two sketch designs and give feedback. Over 400 responses were collected that have been considered in the development towards a provisional design. The development of the provisional designs started in January 2021 and was also opened up to public responses through a 'Think-along app'. It is expected that a decision on the proceeding of the F50 and the final route will be made in January 2022. Thereafter, the provisional design will be further elaborated towards a final design. When the official agreement is signed, the realization can begin.

[1] A regional organization that is involved in managing sustainable innovations such as cycle highways.

Figure 4. Location of the cycle highway cases used in this study. Adapted from *Gemeentenatlas* website, by Gemeentenatlas, 2021, retrieved from https://www.imergis.nl/map/2021/2021-NL-Gemeenten-basis-2500px.png

4.3 Data Collection and Analysis

In this study three data collection methods were used to answer the four sub-research questions (Table 4). First, a literature review was conducted from June 2021 till September 2021. It helped contrast two design logics and understand how they may inform bicycle planning. Next to this, specified institutional factors were reviewed in academic and grey literature to see how they may influence the design of Dutch cycle highways. Second, semi-structured interviews with practitioners from three cycle highway projects examined the logic behind the design and how the identified institutional factors influence the design. Third, in addition to the semi-structured interviews, content analysis of project documents was conducted to provide another source of evidence. This data triangulation technique helps the qualitative researcher to reduce the impact of potential biases (Bowen, 2009).

Table 4

To what extent and how are cyclist types and cycling experiences reflected in the design of cycle highways in the Netherlands?				
Sub-research question	**Which information**	**Sources**	**Method of retrieval**	**Method of analysis**
1. How is the cyclist perspective considered by the contrasting design logics: the conventional transport approach and sustainable mobility paradigm?	Insights from literature about transport planning paradigms that can be used in bicycle planning and how these differ in their rationalities/logic	Scientific, peer-reviewed articles from academic journals	Digital academic search engines (SmartCat, Google Scholar)	Literature review
2. What institutional factors can influence the design logic behind cycle highways?	Information on policy, financial agreements and existing design standards and how they may influence the design of cycle highways	Policy documents, publications of governmental organizations	Digital search engine (Google)	Literature review
3. To what extent do current developing designs of Dutch cycle highways follow the conventional transport or sustainable mobility logic?	Information from project documents about the considerations of cyclist types and experiences in the design	Project documents	Archives from provinces, municipalities or project website	Document analysis / Deductive coding in ATLAS.ti
	Information from the practitioners about their definitions and considerations of cyclist types and experiences in the design. Identifying potential design logics that inform this.	Practitioners involved in the route choice and design of the cycle highway	Semi-structured interviews	Transcription and coding deductively and inductively in ATLAS.ti
4. How are current developing designs of Dutch cycle highways influenced by institutional factors?	Information from project documents about the influence of the predefined institutional factors, and potentially emerging ones, on the design	Project documents	Archives from provinces, municipalities or project website	Document analysis / Deductive coding in ATLAS.ti
	Information from the practitioners about the influence of the predefined institutional factors, and potentially emerging ones, on the design	Practitioners involved in the route choice and design of the cycle highway	Semi-structured interviews	Transcription and coding deductively and inductively in ATLAS.ti

4.3.1 Document Research

In order to gain information on the design logics and the influence of institutional factors in the specific cases (sub-research questions 3 and 4 in Table 4), project documents were retrieved for analysis. This research technique is based on identifying concepts from theory. According to Bowen (2009), documents can provide supplementary research data that are valuable additions to a knowledge base. As such, the document analysis can provide background and context, but also additional questions that can be asked in following data collection methods. By reviewing public records such as implementation documents, intention declarations and masterplans, the three cases were analyzed in more depth. Using the same topic guide (Appendix C) as the semi-structured interviews, information was gained on these specific concepts that were derived from the literature review. The documents used per case are listed in Appendix B.

Nevertheless, there are two issues that need to be considered when engaging in document analysis. First, pre-existing texts need to be thoughtfully considered in relation to subjectivity. As O'Leary (2009) argues, documents are often written with a specific target audience in mind. The bias or purpose of the author of the documents needs to be considered as well as one's own bias. As with any method, how useful information is drawn from the documents will be colored by one's own reality (O'Leary, 2009). The second issue that O'Leary (2009) points out, is the latent content of the document. This refers to the style, tone, agenda, facts or opinions in the document that one should be aware of. The facts given may not necessarily be complete, precise or accurate (Bowen, 2009). These two issues were kept in mind when gathering relevant documents and exploring their content.

Analysis

For this technique, pre-existing categories imposed by academic literature are used. O'Leary (2009) refers to this technique as content analysis. Based on the research question and literature review, certain predetermined words, phrases and concepts are coded. By coding deductively based on the topic guide in Appendix C, the document was organized. The analysis also allowed for inductive codes, that were related to higher order deductive concepts, to arise from the documents. Figure 5 provides an example of this coding technique and subsequent data structuration technique. In this step the document is organized and frequency of occurrences are noted. Next, the information is organized into what is related to the central research question (Bowen, 2009). Based on the extent and way that the concepts receive attention in the documents, a document was created that summarizes the case-specific information. This information is then further used as background information for the semi-structured interviews and as another source of evidence. Documents were retrieved through online search engines and listed in Appendix B.

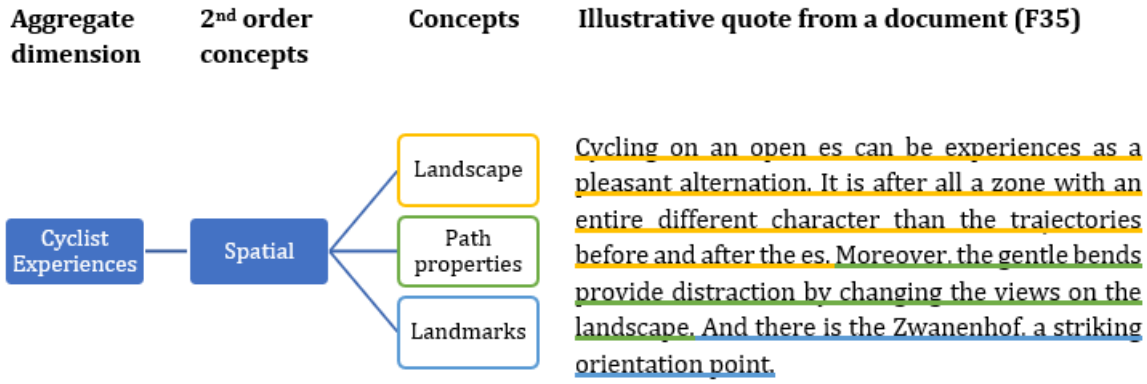

Figure 5. Example of a part of the data structure from the document analysis

4.3.2 Semi-structured Interviews

Semi-structured interviews were held to answer the third and fourth sub-research questions (Table 4). The interviews followed a topic guide (Appendix C) that was derived from the literature review in this study. Semi-structured interviews lent the needed structure to the interviews but still gave respondents the freedom to express their views on the topics (Dunn, 2005). Moreover, the use of open-ended questions allowed for understanding personal context, motivations and outcomes of respondents. As such, an in-depth understanding of the respondent's considerations was gained.

The selection of respondents was based on experience and involvement in the cycle highway project as case study. Hence, the selection was carried out non-randomly by contacting the respondents directly or indirectly. The available documents on the cycle highway project cases often listed the names of practitioners involved in the project. Recruitment of respondents was either carried out by contacting these listed practitioners via email or telephone. When project documents did not list names of practitioners, the province or municipality was contacted to obtain the correct contact details. Furthermore, snowball sampling was used in some cases to identify other involved practitioners in the cases under study. Table 5 provides an overview of the respondents in this study and the interview details.

Table 5

Case study	Respondent	Role	Interview Date	Interview Location
F50	1	Project leader F50 – Cleantech Regio	4-11-2021	Online
	2	Policy advisor mobility – municipality Apeldoorn	10-11-2021	Online
	3	Project leader fast cycling routes – Province Gelderland	4-11-2021	Online
F35 Almelo-Borne	4	Policy advisor Traffic – municipality Borne	2-11-2021	Online
	5	Traffic expert – municipality Almelo	27-10-2021	City hall Almelo
	6	Project leader – Province Overijssel	26-10-2021	Province hall Zwolle
Doorfietsroute IJsselstein-Utrecht	7	Project leader Fiets – Province Utrecht	2-11-2021	Online
	8	Policy advisor mobility – municipality IJsselstein	8-11-2021	Online
	9	Policy advisor mobility – municipality Nieuwegein	9-11-2021	Online

Analysis

The semi-structured interviews were gathered through interviews and tape recorded and manually transcribed using Atlas.ti. Thereafter, both deductive and inductive coding methods were applied to generate insights on the phenomena under study. Having a provisional list of codes beforehand can help focus and harmonize with the study's conceptual model (Saldaña, 2009). Hence, a deductive code tree was developed prior to the analysis. Nevertheless, the analysis also allowed for inductive coding as emergent areas of interest, relations and patterns were found.

The codes were structured under higher order codes that resulted in hierarchical coding trees (Appendix F). An example of how the transcribed interviews were coded is shown in Figure 6. The codes attached to the quotes represent the 1st order concepts. The 2nd order concept illustrates the relationships between the 1st order concepts. The aggregate dimension shows the overarching theme between several 2nd order concepts. In the example below, the theme cyclist experiences consisted of four 2nd order concepts: spatial, sensory, social and travel time (coding trees in Appendix F).

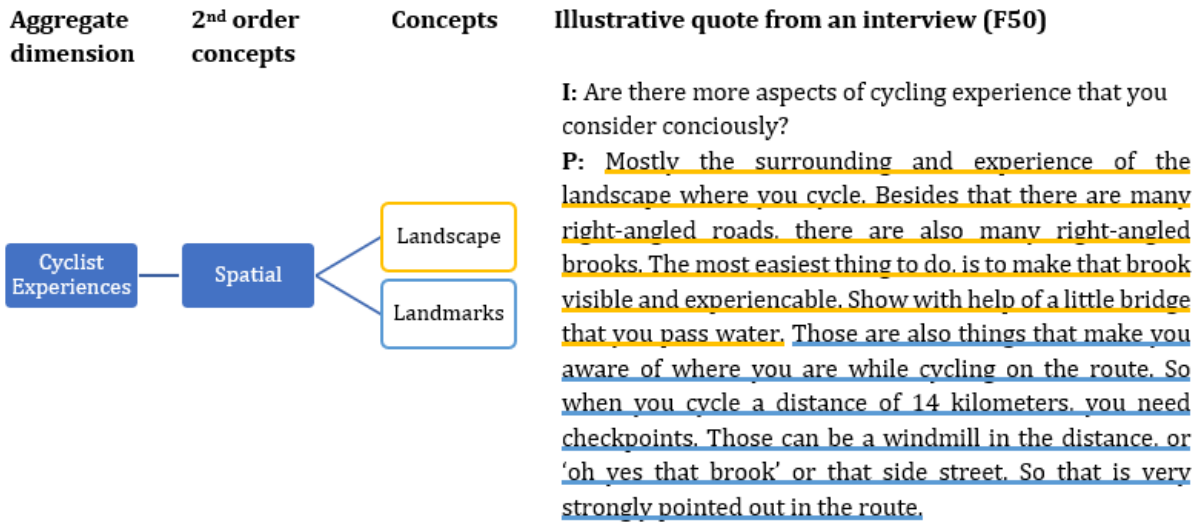

Figure 6. Example of a part of the data structure from the interview analysis

4.4 Ethical considerations

"Ethics is at the heart of high-quality research practice and a consideration that runs through research from the early stages of design to reporting and beyond" (Ritchie et al., 2014, p.108). In light of ethics, this study informed the respondents upfront about several important considerations. They were informed about the purpose of the research, the audio recording and confidentiality matters. All confidentiality and participant rights were included in the information sheet that was provided in advance of the interview (Appendix D). The respondents officially agreed to the terms and conditions by signing the applicant form (Appendix E). As described in this form, the respondent had the right to withdraw from the study until the study had been published and was free to decline to answer any interview questions. Respondents have also been informed on the potential online publication of the study. After the study was finalized, audio recordings have been deleted.

5. Results

In this chapter the results of the content analysis and semi-structured interviews are discussed. In doing so, the findings are presented by following the structure of the literature review and conceptual model.

5.1 Case Study: F35 Almelo-Borne

Name of route: Fietssnelweg F35 (traject Almelo – Borne)
Connection: Almelo – Borne
Province: Overijssel
Municipalities: Almelo, Borne
Current status: In phase 2 (Appendix A). The preferred route on the north side of the train track is being developed as provisional design (VO). Due to financial constraints, and the costs of crossing of the train tracks in this design, the proceeding of the project with this design is currently unclear.

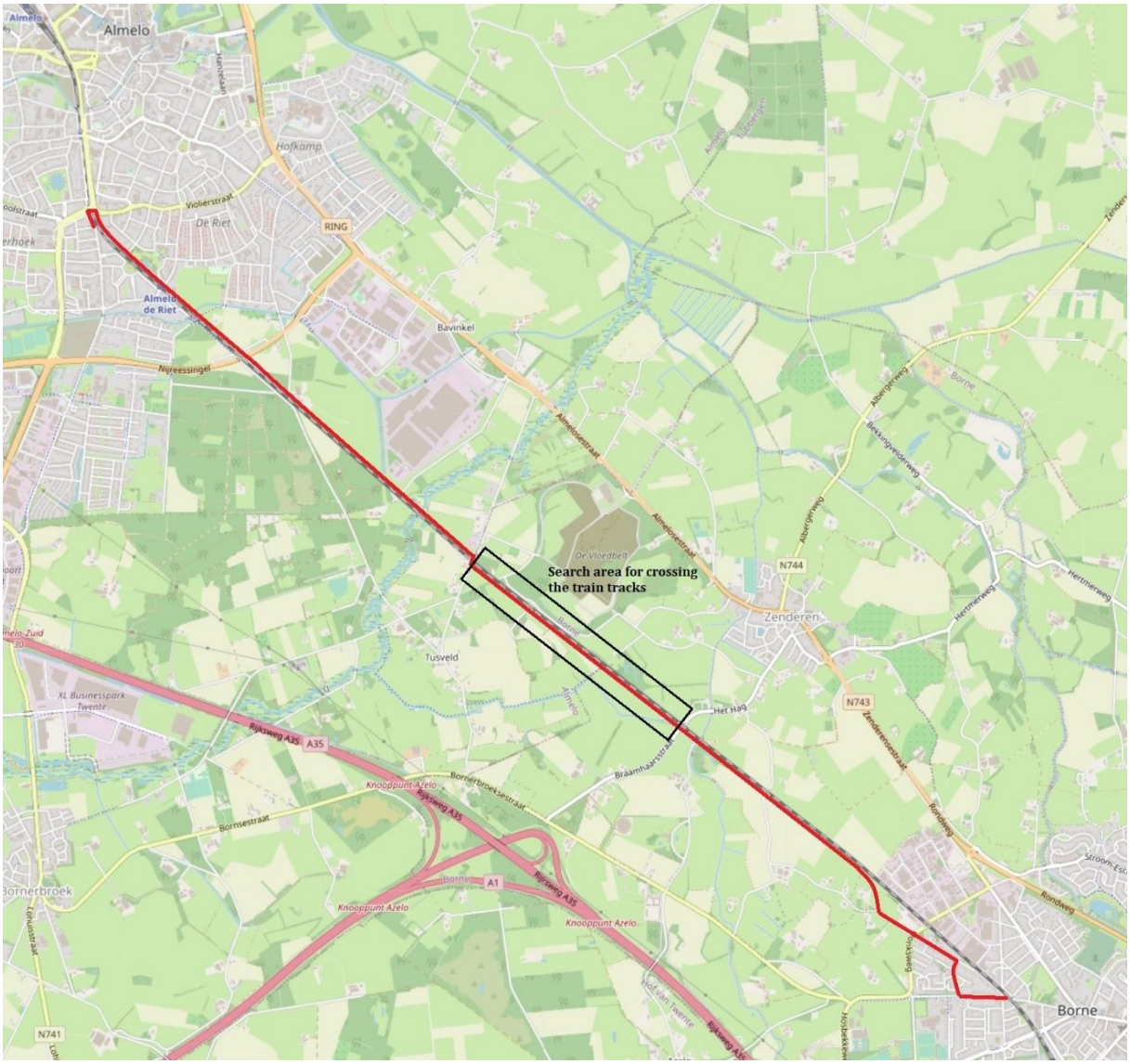

Figure 7. The preferred route on the North side of the train track. Adapted from *OpenStreetMap* website, by OpenStreetMap, n.d., retrieved from https://www.openstreetmap.org/#map=12/52.3323/6.6892

Cyclist Types

The masterplan does not clearly differentiate between cyclist types that will become the users of the F35. This is in line with the wide variety of functions in Twente that will be supported by the development of the F35. The F35 is argued to support multiple functions regarding mobility, social functions, tourism and recreation, economic functions, environmental functions, health, traffic safety and PR. Hence, not one user group stands out from the masterplan. However, from the interviews it becomes clear that the practitioners of the F35 Almelo-Borne have prioritized the mobility function and thereby the commuter as target cyclist type. They state that the vision behind the F35 is to get commuters out of their cars and onto their bicycles. By facilitating infrastructure that increases the competitive position of the bicycle opposed to the car, traffic congestions are aimed to be reduced. With this underlying goal in mind, the primary target group of the F35 is the commuter. Based on other motives the practitioners also recognize that the cycle highway will be used by other cyclist types such as students and recreational cyclists. However, practitioners state that the recreative function is not prioritized when designing the cycle highway.

The F35 tries to accommodate for the needs of commuters and compete with the car highway by facilitating a direct and safe route that connects working areas and living areas. The currently preferred trajectory is positioned parallel to the train track and provides the shortest route between Almelo and Borne. It is argued that *"the average commuter wants to move from A to B as fast as possible by taking the shortest route or fastest one"*. The assumptions of the practitioners are based on their own expert judgement and research that was carried out by the province and advisory agencies prior to the start of the F35 project in 2009. The masterplan has translated the results of this research into certain trajectory requirements that have guided the trajectory options. One of these is sufficient speed: *"In the same time people can cycle further, which makes it more attractive to cycle. Therefore the share of bicycles increases at the expense of other transport modes, especially with commuting motives".* These requirements are further supported by certain design standards that were based on the CROW guidelines. After a masterplan update in 2014 these same design standards with underlying assumptions of the commuter are still guiding the designs of currently developing trajectories. Smaller municipalities point out that they do not have the capacity to inquire recent viewpoints of potential users and their needs. Therefore, the guidelines of CROW and the standards set in the 2014 masterplan are guiding for the design.

Cycling Experiences

The masterplan of 2014 does not clearly address cycling experiences, their aspects and how to consider them in the design of the cycle highway. The document mainly focuses on the functional quality requirements which are based on directness, coherence, comfort and safety. These are supposed to result in a high quality cycle highway on which cyclists can ride smoothly and quickly. The case specific documents that form the advisory report to the trajectory options Almelo-Borne, address the concept of cycling experiences differently. The main Goudappel Coffeng document has assessed the trajectory variants based on the same functional quality requirements as stated in the F35 masterplan. More specifically, they stated that directness should be within a margin of 10% compared to the distance linearly. Moreover, comfort ought to be sufficient with low chances of stopping, meaning staying below 0.4 stops per kilometer. The subjective side of the principles are referred to but do not weigh in when deciding on the preferred trajectory. This reference was to the appendix where the advisory report of the RO Thuisraad on cycling experiences could be found. In this document it was argued that the cyclist perspective is needed to ensure many

cyclists will use the cycle highway because it *'feels'* safe, direct, comfortable, attractive, short in travel time and well oriented. As a result of several design sessions, the document concludes that the experts involved in the Almelo-Borne trajectory have different views on what would feel optimal as a cyclist than the experts on cycling experience do. For instance, the straight trajectory options alongside the railway are by the local experts evaluated as feeling 'direct' and 'short travel time', whereas the experts on cycling experience evaluate it as 'unpleasant' by the lack of positive attractions in the environment. Moreover, unattractive routes are experienced as longer in travel time according to the latter group of experts. Even though the RO Thuisraad advisory report provides different insights regarding the trajectory options, the document was added as a mere appendix to the advisory document of Goudappel Coffeng. This gives one the feeling that the objective findings are prioritized over the subjective side of the story. Especially because the findings of Thuisraad RO are only mentioned and did not weigh in to come to a final recommendation of the preferred trajectory.

The ideal cycling experience was described by the practitioners by referring to subjective safety, attractiveness and continuous movement. Subjective safety is an important consideration in the design of the cycle highway. It reflects the social aspect of cycling experience, as one practitioner describes: *"You want to try to design the route next to a road so that there is some sort of interaction with other traffic. Meaning, if something happens other people can see and respond"*. It is also recognized that facilitating subjective safety in this manner can conflict with the attractiveness of the surroundings: *"You can have a beautiful route through forests and all, but at night people will not feel safe taking this route. It is unattractive, especially for women. You cannot see your surroundings and it is just unsafe"*. Hence, according to the practitioners there can be a tension between spatial experience and social experience. Nevertheless, the spatial experience of a cyclist can also be enhanced by considering smaller elements in the design of the path. For instance by letting the path meander a bit instead of designing one straight line. The ideal cycling experience was also described in terms of sensory experiences. Namely, being able to cycle continuously with minimal stops and hindrances. This experience was often linked to the functional properties underlying the concept of comfort as design standard.

Design Logic

The practitioners reflect aspects from both the sustainable mobility and conventional transport paradigm. In terms of their perception of the future users, the focus on utility is very evident. This is again linked to the commuter and its envisioned needs as the main target group. One practitioner argues: *"We design the cycle highway to get people out of their cars, who use them on a daily basis, the commuter. The commuter wants to get to work as fast and direct as possible"*. There is also a clear link with prioritizing minimal objective travel time. Two practitioners argue that the commuter wants to keep travel time minimal and be at work as quickly as possible. One practitioner recognizes the subjective side of travel time, but also indicates that this is considered very limitedly in the design. Rather priority is given to the cyclist's orientation from A to B. When the cyclist feels like the route is not optimally direct but has a detour this may be illogical to him or her. Still, the overall focus on minimal objective travel time and utility match the principles of the conventional transport paradigm.

These focus points are also reflected in the design considerations of the cycle highway. Namely, a direct design featuring efficiency and speed. Practitioners mention that attractiveness should also be considered in the design. Yet, the basis of the cycle highway should be a fast and direct route

where attractive features can be built in where possible. Just as attractiveness, cycling experiences are also not prioritized in the design: *"Cycling experiences need to be considered, but they cannot be our primary factor of interest. In the end it is about a fast cycling route that we need to facilitate. With that, we have the commuter in mind and not the recreational cyclist".* From this statement it becomes clear that designing for optimal cycling experiences is mainly linked to recreational cyclists. As was already mentioned, the prioritization of speed and directness are based on the set requirements and design standards in the F35 masterplan. These are mentioned by the practitioners to back up certain conventional transport considerations in the design: *"If you want people to start using the cycle highway, it should be direct. You are not going to take a detour that exceeds 1.2 between two points. You can take a giant detour with a magnificent surrounding, but people will not use it, they will take the direct route"*. In sum, the practitioners mainly reflect the conventional transport logic by arguing that the users value minimal objective travel time and its utility function. This is reflected in the design considerations by focusing on directness, efficiency and speed.

Institutional Factors

The design of the cycle highway is not only influenced by the practitioners' perspectives and their considerations of cyclist types and experiences. First and foremost, finances play an important role in the eventual cycle highway design. The masterplan states that in order to be eligible for co-financing from the Regio Twente, certain preferred quality standards regarding comfort and safety need to be guaranteed. Practitioners argue that even with such subsidies there are still financial constraints that guide the eventual design. One practitioner explains how it would be ideal to let the cycle highway meander in the rural areas to improve the spatial experience of the cyclists. However, due to the private properties in these rural areas and financial constraints to buy these properties, it often comes down to a straight path. Second, physical factors play a role in the eventual design of the cycle highway. For instance, the presence of pipes and cables under the ground that forbid asphalt to be constructed on top of it. Removing such physical factors costs a lot of money, which again is a constraint in this case. A third factor is the participation of local residents. Practitioners recognize that the term 'highway' often gives rise to negative feelings and resistance among local residents. Clear communication on what the term cycle highway entails and its dissociation to the car highway concept is therefore deemed important. Still, not in my backyard resistance can form an obstacle to the envisioned design of the cycle highway.

In conclusion, the F35 Almelo-Borne showcases that commuters are the main target cyclist type. This is in line with the vision that the cycle highway is to compete with the car highway in order to reduce traffic congestions. In doing so, the commuter is perceived to value utility and minimal objective travel time. Even though several aspects of cycling experiences are acknowledged by the practitioners, they mainly focus on a functional design as set by the requirements and standards in the masterplan. The reasoning behind the design of the F35 reflects quite some features of the conventional transport logic by emphasizing directness, speed and efficiency. In the translation towards the actual design of the trajectory, features of the sustainable mobility logic are often pushed to the background due to design requirements and financial constraints. The design of the cycle highway is further shaped by physical factors and participatory processes.

5.2 Case Study: Doorfietsroute Utrecht-IJsselstein

Name of route: Doorfietsroute Utrecht – Nieuwegein – IJsselstein
Connection: Utrecht – IJsselstein
Province: Utrecht
Municipalities: Utrecht, IJsselstein, Nieuwegein
Current status: At the beginning of phase 4 (Appendix A). One route is developed as provisional design (VO) and the intention declaration has been signed in October 2021. The VO will in the coming year be developed into a definite design (DO).

Figure 8. Route that is being developed as VO. Adapted from *OpenStreetMap* website, by OpenStreetMap, n.d., retrieved from https://www.openstreetmap.org/#map=13/52.0575/5.0980

Cyclist Types

The informational website of the province Utrecht highlights that the 'fast cycle routes' projects are meant for all cyclists. With that they emphasize that it is not necessary to cycle fast or with a certain speed when using the fast cycle routes. By investing in quality improvements of current busy trajectories, the province aims to make cycling more attractive for longer distances. With that, it adds to an accessible, healthy and attractive province. When zooming into the doorfietsroute Utrecht-IJsselstein documents it becomes clear that the route aims to stimulate cycling among commuters. Nevertheless, the upgrade of the existing cycle path is also meant to give more space to all types of cyclists that are already using the path. Hence, the doorfietsroute seems to target a broad range of current cyclists and non-cycling commuters in particular. The practitioners also recognize this. According to them, the upgraded route should accommodate the current cyclists and the expected growth of cyclists. Furthermore, it is said that the type of cyclist, based on their motive, is dependent upon the trajectory of the route: *"We have many businesses on the south side where the route will pass. For us those commuters are an important target group … Other parts have more students or recreational cyclists".* Based on monitoring and research the current user types were mapped. These different types were however not leading for most design considerations, as the design follows the CROW guidelines. One practitioner explains: *"They [CROW] have already incorporated all these user types in the developed guidelines"*. Yet, the route does try to facilitate the needs of the cycling and non-cycling commuter by connecting living areas with business areas.

The practitioners put emphasis on the inclusivity of the route for all user types and ages. Even though this does not show in the deviation from the general CROW design guidelines, it does show in the communication strategy towards the public. The term 'doorfietsroute' was deliberately chosen to dissociate from the term 'highway' that is often associated with high speeds. According to the practitioners, the chosen term emphasizes the inclusive character of the route for youngsters and elderly with varying motives to cycle.

Cycling Experiences

Cycling experiences were not explicitly mentioned or discussed in the analyzed documents. Overall the practitioners discussed cycling experiences in relation to the social, spatial, sensory and travel time aspect. First, the social aspect was addressed by the practitioners by arguing that the ideal cycling experience would entail having enough space to pass one another on the cycling route itself. Moreover, it entails not having to pay attention to folding car doors or other passing motorized traffic. One practitioner argued that the cyclist will experience being at the top of traffic hierarchy: *"It is a great feeling that cars will have to stop for you instead of the other way around"*. Second, the spatial aspect of cycling experience was addressed by mentioning the importance of an attractive and diverse surrounding where the different seasons throughout the year can be experienced as well. Furthermore, path related properties were mentioned in relation to the spatial experience of cycling, such as including bends into the design. Third, the sensory aspect of cycling experience was addressed by referring to cycling continuously and comfortably on smooth asphalt. Furthermore, one practitioner referred to the ideal cycling experience as one where the cyclist gets into a mental flow. In this flow the cyclists will be at his or her destination sooner than expected. According to the practitioner, this flow is enabled by the cycling experience in general, including a diverse scenery, continuous movement, no difficult interaction with other traffic and smooth asphalt. In this sense objective travel time is not the guiding principle whether to choose a route or not: *"The ideal cycling experience is that you are somewhere sooner than expected, but*

that the actual number of minutes is not the most important argument to choose a route". So, the fourth mentioned aspect of cycling experiences was described in terms of subjective travel time.

Design Logic

The practitioners reflect aspects from both the sustainable mobility and conventional transport paradigm. Hereby, the practitioners seem to have quite diverging viewpoints in relation to each other. Whereas one practitioner's arguments strongly reflect a conventional transport paradigm, another practitioner's arguments are very much in line with the sustainable mobility paradigm. In terms of their perception of the future users, all practitioners agree that people in general will try to limit their physical effort when travelling. Hence, the enormous increase in the number of e-bikes. On the other hand, the practitioners have different ideas about whether cyclists regard their travel time while cycling as a derived demand or valued activity. One practitioner argues: *"Most cyclists there cycle with a goal and want to get from origin to destination as fast as possible"*. Whereas another practitioner says that people actually like to be on the road for a bit because it gives them some time to clear their heads and relax. The different viewpoints of the practitioners with regards to how they perceive cyclists and their experiences, is also reflected in what these practitioners deem important in the design of the doorfietsroute.

The practitioner that views the cyclist perspective as valuing minimal objective travel time and cycling as a derived demand, also prioritizes a direct design featuring efficiency and utility. Namely: *"I think a fast cycling route is characterized by its directness and efficiency. When you design for attractiveness, you have a different cyclist in mind who does not travel under time pressure. So, I think people appreciate it more when the route is as direct as possible"*. Within this statement, the commuter seems to be kept in mind and guiding for the design. The other practitioner that views the cyclist perspective as valuing the activity itself and thinks in terms of reasonable travel time, prioritizes cycling experience and attractiveness in the design. More specifically: *"It is important that you think 'oh am I here already?' That is something you are more likely to experience when the route is attractive, when there are distractions and things to explore, instead of having a road that is straight as an arrow. Like as if you cycle over the Afsluitdijk"*. Even though these two perspectives of these practitioners are following different design logics, they do not necessarily clash. The other practitioner mentions that a direct design goes hand in hand with an attractive design in this case. By following the canals in the urbanized area, directness and attractiveness are both accounted for in the design. Hence, adhering to both the sustainable mobility and conventional transport logics underlying it. The interplay of both logics is also mentioned in relation to different moments in time that the commuter finds itself and its mindset. A more car minded commuter can be persuaded to choose bicycle over car by emphasizing the directness and fastness of the cycling route. Once he or she is cycling, the commuter should have an optimal cycling experience, facilitated by the doorfietsroute. A cycling minded commuter who already cycles and views it as an appreciated activity will not have to be persuaded beforehand, but purely be satisfied by getting an optimal cycling experience, including a diverse and attractive surrounding. That way, both design logics are argued to be needed to some degree.

Institutional Factors

The doorfietsroute design is not only influenced by the practitioners' design logic and how they consider cyclist types and experiences. Physical factors play an important role in designing the doorfietsroute in a predominantly urban area. Space is often limited and therefore constrains certain ideal design features. One practitioner states: *"We try to adhere to the CROW guidelines*

regarding the width, lining and bend radius. Especially regarding the width, concessions have to be made sometimes". Within these urban areas the existing cycle infrastructure also plays a role. More specifically, the practitioners try to make use of the existing infrastructure in the new design: *"When there is a cycling path quite close to the car road, we will not say 'let's make a new cycling path 10 meters from the car road', only because the cycling experience would benefit from it"*. Hence, pragmatism also influences such design considerations. Next to pragmatism and physical factors, finances also play a role. practitioners argue that when financial cuts have to be made, it often concerns certain design elements: *"You always see there is money for asphalt, but affordances that add to the cycling experience are often being cut out due to financial issues"*. In sum, the design is further influenced by physical factors, pragmatism and financial factors. Due to these factors concessions to the ideal design have to be made. This often pushes the design into a pragmatic design that does not prioritize principles from the sustainable mobility logic.

To conclude, the doorfietsroute Utrecht-IJsselstein aims to facilitate all types of cyclists and target the non-cycling commuter to start cycling. Emphasis is put on the communication towards the public while the design follows the standard CROW guidelines. The different aspects of cycling experiences are recognized by most practitioners. Yet, the way cyclist types and experiences are understood and considered by the practitioners in the design differs substantially. Namely, one practitioner's reasoning reflects a rather conventional transport logic where emphasis is put on utility, efficiency and directness of the route. Another practitioner's reasoning reflects more an sustainable mobility logic focusing on cycling experiences, subjective travel time and an attractive route. In this case the two design logics do not conflict but are combined into a route that is both direct and attractive. The design is further shaped by physical and financial factors, where pragmatism is often leading.

5.3 Case Study: F50 Apeldoorn-Epe

Name of route: Vlot en veilige fietsroute Apeldoorn – Vaassen – Epe
Connection: Apeldoorn – Epe
Province: Gelderland
Municipalities: Apeldoorn, Epe
Current status: At the end of phase 2 (Appendix A). Two routes are developed as provisional designs (VO). A decision on the proceeding will be made in January 2022.

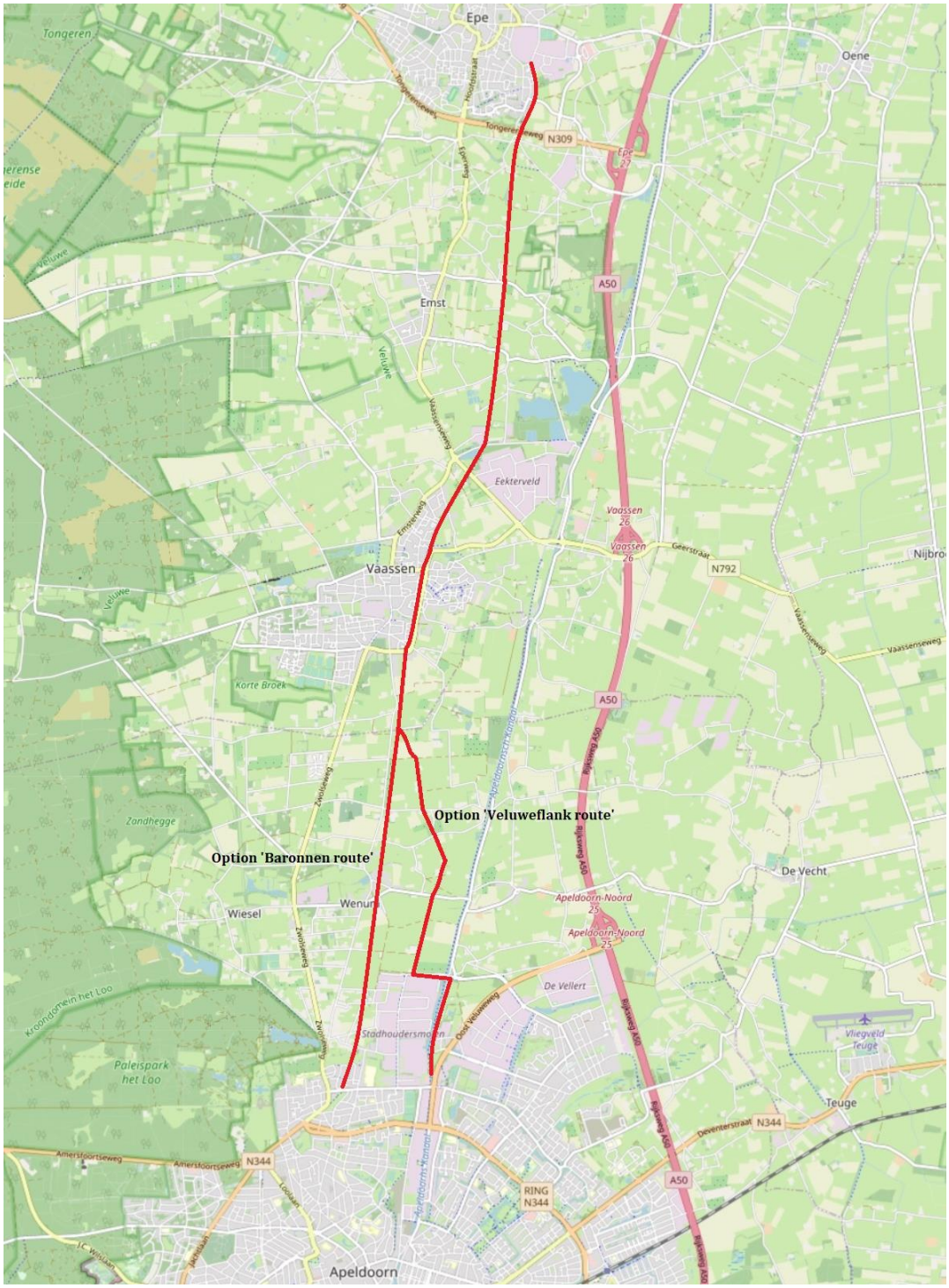

Figure 9. The two routes of the F50 that are being developed as VO. Adapted from *OpenStreetMap* website, by OpenStreetMap, n.d., retrieved from https://www.openstreetmap.org/#map=12/52.2917/5.9832

Cyclist Types

The Goudappel Coffeng report showcases that the F50 is meant for all types of cyclists. Based on motives, commuters, students and recreational cyclists are mentioned. Next to this, it becomes clear that the F50 does not only focus on attracting new cyclists, but also values the already cycling cyclist group. It is stressed that this latter group is likely to switch to other modes of transport when these seem more attractive. Therefore, the development of the F50 also aims to retain current cycling users of surrounding cycling infrastructure.

The practitioners also recognize the three cyclist types that were mentioned in the report, as future users of the F50. Next to these, they also mention non-cyclists such as residents who walk their dog. The various user groups have been considered in the design with regards to the connection with their destinations or facilities. For instance, the practitioners look at the coherence with other cycling paths that connect the F50 to business areas or schools. The practitioners assumptions on the needs of the various user groups are based on expert judgement, personal cycling experiences and participatory processes. One practitioner argued to cycle the potential route on a monthly basis to personally experience the route as a cyclist in different seasons of the year. The participation process included the inquiry of viewpoints from a sounding board group during several phases of the design process. Next to this, people could address their opinions on the sketch design by marking a spot on an interactive map application online. The input of these participatory sessions have been considered in the design of the F50. However, the practitioners also mention that the basis of the design is guided by a set standard and not guided by the different inquired needs of the cyclist groups. More specifically, as the F50 is a concept that aims to provide a quick and safe route, the design is based on a speed of 20/30 km per hour. Hence, the bends are gentle and stops are minimal.

Cycling Experiences

Cycling quality was one of the weighing factors for the trajectory options that were examined in the Goudappel Coffeng report. Even though it was not clearly defined, this factor included several aspects of cycling experience. These aspects were also reflected in the interviews with the practitioners. First, the social experience of cycling was addressed in the report by referring to the subjective safety of the cyclist. This involved the safety of cycling during night, but also in relation to other traffic in general. One practitioner added to this: *"Having street lights when it gets dark and that cars will stop for you, also that you have the feeling they will stop for you".* Second, the spatial experience of cycling was shortly mentioned in the report by referring to a diversity in landscapes. The practitioners mention that the F50 will run through a beautiful landscape which should be experienced when one is cycling. One practitioner explains: *"Make the small canals visible and experienceable by going over them using a little bridge in the design"*. Another mentioned factor of spatial experience is landmarks. These recognizable features in the surroundings of the F50 are expected to give the daily cyclist a clear indication where they are and how much longer it will be until they reach their destination. This design feature is mainly meant for the daily commuting cyclist. There are however also other design considerations regarding spatial experience that are meant for different cyclist types. For instance, the facilitation of informational signs and resting spots for recreational cyclists. Certain affordances alongside the route are meant to be multifunctional: *"A rest point can function for instance as a waiting spot for students or as a lunch spot for recreational cyclists"*. Third, the sensory experience of cycling was mentioned in the report by considering the protection from wind and rain on parts of the route. The practitioners add to this that cyclists should not experience the nuisance of noise and bad smells from other

traffic. This also adds to the experience of a mental flow, which one practitioner describes as the ideal cycling experience: *"That you can cycle in a flow, thoughtless and comfortable"*. Last, the role of subjective travel time was not explicitly mentioned in the report. The only reference to the experience of travel time was made by mentioning it should be a logical direct route from A to B. One of the practitioners mentions, based on a study, that cyclists are willing to make a detour of 10% when the route is more attractive. Hence, cycling experiences and attractiveness are argued to become more important in the cycling scene.

Design Logic

The extensive descriptions and considerations of cycling experiences suggests that the project team carefully considers the cyclist perspective. The sustainable mobility paradigm is clearly reflected in the way the practitioners perceive the users of the cycle highway and translate this to the design. To start, cyclists are assumed to view cycling as an appreciated activity. In other words, most people cycle because they like to cycle and not because they have to. Given this assumption, it is also expected that most people accept to make a little detour when the route is more attractive. One practitioner argues: *"For the cyclist it is also about the process and not just the results or destination so to say"*. Here travel time is argued to be of value to people and should not just be considered as a cost. More specifically: *"People use travel time also as a transition from one phase of the day to the other. These are moments when you can clear your head"*. Furthermore, the practitioners do recognize that not all cyclists are the same. Some will try to minimize their physical effort in travelling whereas others will perceive their physical effort as rewarding. Both views are considered in the design: *"We want to facilitate short, quick and comfortable routes, but also facilitate minimal stops and gentle bends so that you can cycle actively and fast if you want to"*.

The assumptions of cycling as an appreciated activity where cyclists value reasonable travel times in combination with an attractive journey, are guiding for certain design considerations. The understated role of attractiveness is raised by one practitioner. It is argued that: *"The route has to be somewhat efficient, but attractiveness is still very important. So when you can make the route way more attractive by positioning it a bit out of the way, we will do it"*. When discussing the conventional transport logic with the sustainable mobility logic, the role of cycling experiences is considered most important: *"A fast movement between A and B may be desirable as well, however, when talking about cycling it is the experience of the cyclist that matters"*. In sum, the practitioners mainly reflect a sustainable mobility logic by viewing cycling as an appreciated activity where the cyclist's perspective should guide the design.

Institutional Factors

The design of the F50 is not only guided by the design logic reflected by the assumptions and considerations of cyclist types and experiences by the practitioners. Again, finances have a big influence on the design of the F50. First, co-financing is linked to certain design requirements. According to one practitioner these requirements are changing through the years. For instance, the set path distance used to be 4 meters but currently requires 4,5 meters. It is argued that the increasing standards make it hard for practitioners to make the cycle infrastructure spatially fit. Furthermore, it becomes increasingly difficult to sell such developments in general to the local residents: *"Four meters is already an average rural road in this area. People feel like a landing strip will be the result of such a project"*. Hence, spatial fitting and local resistance are two other factors related to finances that influence the design of the cycle highway. Next to this, political decision making influences whether the F50 project may continue and if so with what trajectory. Especially

with upcoming elections, politics can seriously influence the continuation of the design process. If the project may proceed, serious considerations have to be made with regards to the ideal design and the design requirements and linked financial funds. It could result in a shift from a design led by the sustainable mobility logic towards a design led by conventional set standards.

In conclusion, the F50 targets different types of cyclists and non-cyclists. Based on expert judgement and participatory processes the design should accommodate the various future users, with at the core a design based on set standards. The practitioners describe and consider cycling experiences extensively by focusing on cycling as an appreciated activity and attractiveness of the route. It further reflects a rather sustainable mobility logic that considers the unique perspective of the cyclist. However, when translated to the actual design it is recognized that concessions will have to be made in order to fit design requirements and be eligible for financial funds. The result will probably be a more general design that reflects principles of the conventional transport paradigm.

6. Discussion

The goal of this study was to explore to what extent and how different cyclist types and cyclist experiences are considered in the design of cycle highways in the Netherlands. The results from three case studies show that, based on trip purpose, the commuter is often the envisioned cyclist and non-cyclist type. Cyclist experiences are generally recognized, but not always considered in the design. Steered by different design logics and influential external factors, the cycle highways are shaped top-down. In this chapter these findings are discussed in more depth and in relation to the existent theory. Hereafter, it touches upon this study's scientific contributions and practical implications. Lastly, this chapter discusses the limitations of this study and suggestions for future research.

Cyclist Types

When speaking of cyclist types, all practitioners from the three cases identified different potential user groups in terms of trip purpose. As such, the commuting cyclist, recreational cyclist and student cyclist were often mentioned. Haustein and Hunecke (2013) recognize such a categorization approach as one that is based on travel behavior. Next to focusing on travel behavior, cyclist types can also be classified based on sociodemographic and attitudinal variables. However, in practice these latter two categorization approaches are not employed. According to Haustein and Hunecke (2013), focusing solely on trip purpose can be useful to describe various groups, but fails to address the underlying mechanisms that explain certain travel behavior. In order to stimulate cycling in the transition towards sustainable mobility, especially cyclist categorizations based on attitudinal variables and behavioral theories are found to be useful (Haustein & Hunecke, 2013). Therefore, practice may benefit from cyclist categorizations that are based on a multitude of factors, because it allows for design adjustments to target specific groups.

The results showed that another cyclist type categorization based on travel behavior was mostly implicitly made between non-cyclist and cyclist. Only in the Utrecht-IJsselstein case this distinction was explicitly addressed by recognizing that the design should foster both the current cyclist and attract potential new cyclists. The F50 implicitly referred to the importance of both groups, whereas the F35 case focused strongly on attracting currently driving commuters to start cycling on the cycle highway. According to Bruno and Nikolaeva (2020) many current cycling innovations have the tendency to focus on the non-cyclist group by making it attractive for them. However, this focus can also form a distraction from the current cyclists and the importance of sustaining this group. Oakil, Ettema, Arentze and Timmermans (2016) found that people were almost three times as likely to shift from bicycle to another mode than the other way around. Hence, Te Brömmelstroet et al. (2020) argue that "a cycling culture is shaped and defined by existing cyclists, and a transition to a sustainable transportation system starts with understanding, supporting, and investing in the practices of those people" (p.3). So, when designing cycle highways it is important to take the needs and experiences of current cyclists seriously. This means acknowledging cyclist types both in terms of current cyclists and non-cyclists, and in terms of categorization based on multiple factors as described above.

Cycling Experiences

Considering the argument of Te Brömmelstroet et al. (2020) about sustaining current cyclists, the importance of cycling experiences becomes even more evident. The results show that the conceptualizations of cycling experiences in practice can be linked to the conceptualizations

proposed by Liu et al. (2018). Namely, that cycling experience is a social, spatial and sensory phenomenon. Next to this, the experience of travel time was addressed by several practitioners.

First, the social experience of cycling as conceptualized by Liu et al. (2018) was strongly evident in the IJsselstein-Utrecht case. Here, the interaction with other traffic in urbanized areas was the main point of attention. It was argued that the design should facilitate a cycling experience of feeling unhindered, prioritized and more important than car drivers. Second, in all cases the sensory experience of cycling (Liu et al., 2018) was considered in the design of cycle highways. For instance, by trying to facilitate the sensory experience of being in a 'flow'. More specifically, being able to move continuously with minimal stops, smooth asphalt and minimal disturbing traffic noises. Third, also the spatial experience of cycling referred to by Liu et al. (2018) was reflected in the case studies. The F50 in particular, clearly reflects design considerations that facilitate spatial experiences. For instance by considering landmarks, the quality of the landscape and other cyclist specific affordances. One of these are shelters to change into rainsuits before cycling alongside vast plains. This kind of planning for the cyclists' exposure to weather conditions is in line with the argument by Böcker et al. (2015), that these are important considerations for the usage of the route. The fourth and last aspect of cycling experience that was mentioned by Olde Kalter and Groenendijk (2018) was that of subjective travel time. Quite some practitioners acknowledged the relationship between a diverse and attractive route and lower subjective travel time. They argued that in the ideal design this is facilitated by meandering and landscape features.

Designing from the perspective of the cyclist and its embodied experiences reflects some of the main principles behind the sustainable mobility logic proposed by Banister (2008). Namely, valuing the activity of cycling, putting the pedestrian and cyclist at the top of the transport modes hierarchy and seeing travel time as something largely subjective (Marshall, 2001; Banister, 2008). Even though cycling experiences were recognized by the practitioners, they were not always considered in the same way and extent in the design of the cycle highways. The underlying design logics that were identified from the practitioners rationalities partially accounted for these variations. Next to these, also external factors influence the eventual consideration of cyclist experiences in the designs of the cycle highways.

Design Logics Elaborated

The way cyclist types and experiences are considered by the practitioners in the designs of the cycle highways differ. In general, both the conventional transport design logic and sustainable mobility design logic were identified among the practitioners of the cases. These resonated with the principles from the two theoretical paradigms that were mentioned by Banister (2008) and Marchall (2001). The results further showed underlying explanations regarding the target group and goal of the cycle highway. These complement the design logics based on the two paradigms and give rise to two more holistic logics. These are the car logic and the bicycle logic (Figure 10).

First, from a car logic the cycle highway is framed as a concept that responds to the increasing traffic congestion and aims to change commuting behaviors. This is in line with what Skov-Peterson et al. (2017) have argued to be the main intent of cycle highways. As such the cycle highway is a type of infrastructure that aims to tempt car drivers to switch to the bicycle as their daily mode of travel. The practitioners clearly recognize this aim and consider it in certain design considerations of the cycle highway. This is done by focusing on a fast and efficient cycle route that can compete with the car. Hence, design principles that match the conventional transport

paradigm are dominant. More specifically, the focus on utility, minimizing objective travel times and seeing travel as a derived demand (Marchall, 2001; Banister, 2008). It is also in accordance with what Sargentini and Valenta (2015) have called car-oriented thinking when planning for cycling infrastructure. Their criticism on this way of thinking emphasizes the uniqueness of the cyclist perspective and was identified in this study as the second logic.

Second, the bicycle logic was also evident to some extent in all three cases. In line with what Rayaprolu et al. (2018) have argued, cycle highways can also be seen as a reaction to accommodate for the changing needs of society and its cyclists. Especially with regards to the increasing popularity of e-bikes and rising environmental and health consciousness. Different from the car logic that focuses on persuading car drivers, the bicycle logic puts the cyclist central. In line with the recommendation of Forsyth and Krizek (2011), several practitioners prioritize the unique perspective of the cyclist in designing cycle highways. Based on existent academic research, the practitioner's expert judgement and personal experience as a cyclist, they try to focus on the perspective of the cyclist in general. They do so by focusing on cycling experiences and paying attention to the attractiveness of the route. These design considerations are in accordance with the principles from the sustainable mobility paradigm proposed by Banister (2008).

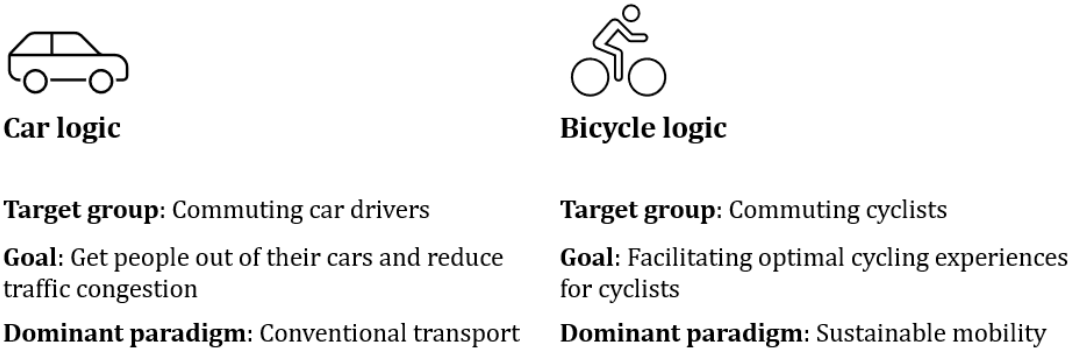

Figure 10. Two logics for designing cycle highways

The results have shown that both logics, including paradigms, are represented in practice. Whereas in most cases the practitioners lean more or less towards one of the two logics, it is also possible that both logics are strongly represented within the project team of one case. Even though the underlying assumptions about cycling and cyclists are different, the results show that they do not necessarily clash when designing the cycle highway. More specifically, in the Utrecht case it became evident that attractiveness and directness can go hand in hand. More detailed exploration of the potential interplay of the two design logics is needed to understand how this exactly works in practice.

From Design Logic to a Final Design

The extent to which different cyclist types and experiences are reflected in the design of the cycle highway depends on two aspects. First, the dominant design logic of the practitioners involved in the project as described above. The results have shown that even within cases the rationalities behind the envisioned designs can be divergent. Second, many external factors were identified that influence the extent to which the practitioners' rationalities are translated into the design.

In line with the study by Liu et al. (2019), funding plays a big role in the prioritization of certain design considerations. First of all, in order to be eligible for co-funding, adherence to the most recent design guidelines by the CROW is oftentimes required. According to the practitioners this takes away the flexibility of designing. The importance of flexibility in the design has been stressed by Sargentini and Valenta (2015), who argue that it allows for adaptation to area specific circumstances. For instance, by meandering around running waters instead of cutting straight through them by going over or under them. However, as practitioners mention, this type of flexibility does not always go hand in hand with the CROW guidelines that have often become strict requirements. Therefore, concessions are made that prioritize the objective and standardized design principles such as directness that should not exceed 1.2 as a detour factor. Another complicating factor that relates to the strict CROW guideline adherence, is the NIMBY-attitude by local residents. It was argued that while the guidelines are being adjusted to accommodate more modalities and different speeds, by expanding the minimal width from 4 to 4,5 meters, it becomes harder to sell the cycle highway to the local residents. The residents feel like a landing strip will be built in their front yards. Also here, the call for more design flexibility suggested by the research of Sargentini and Valenta (2015) is being reflected in practice. Next to funding, the adherence to CROW guidelines and local attitudes there are also physical factors that influence the extent to which practitioners' rationalities are translated into the design. Present physical or spatial features such as cables, pipes, trees, historical values and property rights influence the design. Through a rather pragmatic approach these factors are dealt with. This for instance has also guided the decision to position the F35 parallel to another line element, the train track. This limits the number of intervening crossings and costs of the design.

So, similar to the findings of Liu et al. (2019) and Te Brömmelstroet et al. (2020), there are many external factors at play that influence the design of cycle highways alongside the rationality of practitioners themselves. These factors often steer the design into one that reflects a more conventional transport approach to transport planning. Meaning that technical and generalized guidelines are prioritized over lived cycling experiences that may demand a more flexible design approach. However, the identified external factors and the extent to which they influence the design are case specific. As are the rationalities of practitioners and the cycle highway logic they tend to follow. Nevertheless, they do both influence the design of the cycle highway to a certain extent. This finding is in line with the suggested staging mobilities model of Jensen (2013). More specifically, infrastructural scenes are shaped from above by planning, design, regulations and institutions.

Contributions and practical implications

This study contributes to the extant literature on the design of cycling infrastructure in two ways. First, this research has conceptually connected the top-down perspective of the staging mobilities model of Jensen (2013) with the research of Banister (2008) on the two contrasting transport paradigms. It demonstrates that current Dutch cycle highway designs are partially shaped top-down through practitioners' perspectives of cyclists that follow principles from the conventional transport and sustainable mobility paradigm. With that, this study sheds light on the role of the practitioner's perspective in staging cycling scenes from above. Second, this study has reconfirmed that the design of cycle highways is also influenced by the institutional context. As was suggested by Jensen's model (2013) and the studies of Liu et al. (2019) and Te Brömmelstroet et al. (2020), many institutional factors are at play that influence the design. The current study has

further explored these factors in the Dutch context and identified institutional as well as practical obstacles in the realization of an envisioned design.

Next to the contributions to the literature on the design of cycling infrastructure, this study also provides insights for practice. It has explored how cycle highway mobilities are staged from above. In doing so, it has found that the eventual design is often argued to reflect a standardized conventional design. Sometimes due to dominant conventional design logics, but more often due to external factors that prioritize objective technical design guidelines. Considering the rising academic attention to the unique perspective of cyclists and their user experiences, practitioners seem aware of the importance of subjective cyclist experiences. However, they often have to adhere to strict vehicular parameters that are incorporated in the CROW design guidelines. This study suggests practice to reconsider these guidelines and pay more attention to the soft subjective side. On the one hand, this implies allowing for more flexibility in the existent technical design guidelines. According to Sargentini and Valenta (2015), such flexibility is likely to accommodate more optimal cycling experiences as it allows for area specific adaptation. On the other hand, it implies making case specific inquiries on the experiences of current cyclists between A and B. As shown by academic research there are many evaluative methods to inquire the social, spatial and sensory aspects of cycling experiences. Employing techniques such as mental mapping, visioning, riding-along and interviews can aid practitioners in clarifying what, where and why cyclists experience things in a certain way (Manton et al., 2016). Incorporating this subjective side in the design of cycle highways would reflect a more bicycle-oriented logic.

Next to this, the current study informs practitioners to differentiate between various types of cyclists on attitudinal variables as well as trip purpose. As Haustein and Hunecke (2013) have argued, attitudinal variables can shed light upon the reasons why people use the cycle highway or not. As cycle highways are often framed to aid the transition towards sustainable mobility, knowing why people cycle can add to a successful cycle highway design. Additionally, this study stresses the importance of considering the current cyclist and his or her experiences and needs in the design. For practice this implies that further investigation is needed on the perspectives of various types of cyclists. The varying demands of the different types could be compared and combined in an evaluation framework for cycle highways. Such a framework would indicate design criteria that fit the needs of the wider cyclist population types better. This could also be a relevant avenue for future research as the transition towards sustainable mobility starts with understanding and facilitating the current cyclist (Te Brömmelstroet et al., 2020).

Limitations and Future Research

In general this study has provided some valuable contributions to science as well as practice. Nevertheless, this study also has some limitations. These will be discussed together with suggestions for future research. First, the documents for the document analyses differed in style, purpose and authors. For instance, whereas in the F35 case an extensive masterplan was publicly available, the doorfietsroute Utrecht-IJsselstein only provided website sources and signed declarations. As a consequence, the design principles were touched upon to various extents. Next to this, certain documents originated from advisory companies whereas others from the project team themselves. Even though the advisory documents follow the standards set out by the project team, they still originate from professionals with perhaps different perspectives. These issues were thoughtfully considered in the document analyses as was suggested by (O'Leary, 2009). However, the varying styles, purpose and authors may still have influenced the results.

Second, the three cases that were explored in-depth in this study only represent a small number of current cycle highway projects in the Netherlands. It was found that besides the practitioners perspective, also institutional variables play an important role in the extent to which the cyclist perspective is reflected in the eventual design of the cycle highway. Provinces often play a role in providing co-funding for the cycle highways and set certain design requirements. However, this study only looked at three cases in three different provinces. In order to get a more generalizable understanding of the Dutch context, it is suggested to include projects from other provinces in future research.

Another avenue for future research is to explore the bottom-up, staging from below perspective. The current study has provided a comprehensive overview of how cycle highways are staged from above based on Jensen's (2013) model and Banister's (2008) paradigms. However mobilities are both staged from above as well as acted out from below (Jensen, 2013). In order to fully understand the use of cycle highways, the bottom up perspective should be studied in addition to the current study. Research focusing on this perspective could investigate the experiences, motives and needs of different user groups. As mentioned previously, such insights could be translated into an evaluative framework that helps practitioners design cycle highways that optimally accommodate its users.

7. Conclusion

In this study the following research question was central: *"To what extent and how are cyclist types and cycling experiences considered in the design of cycle highways in the Netherlands?"*. This question was answered in several steps. First, academic literature was reviewed to understand the concepts and how the cyclist perspective receives attention by existing theoretical paradigms. The literature review identified the conventional transport paradigm and sustainable mobility paradigm that considered the cyclist perspective in different ways. The conventional transport paradigm follows a logic that prioritizes speed, efficiency and utility because travel time is seen as a cost. The sustainable mobility paradigm follows a logic that prioritizes the experience and the activity itself because travel is seen as something valued. Hence, paying more attention to the unique perspective of the cyclist as opposed to the conventional paradigm.

Second, based on the staging mobilities model by Jensen (2013), institutional factors were explored that could influence the design of cycle highways in the Dutch context. Reviewing grey and academic literature revealed that the CROW provides five guiding design principles that are deemed influential in the Netherlands. Furthermore, finances can influence the design, especially because they are often intertwined with set design requirements by governments. Lastly, because cycle highways cross local administrative boundaries many stakeholders are involved in the design. These include both governmental bodies as well as local residents that can exert pressure on the envisioned design of the cycle highway.

Third, three case studies in the Netherlands were explored to find out to what extent the envisioned design follows the conventional transport or sustainable mobility logic and how institutional factors influence this in practice. Based on project document analyses and semi-structured interviews with practitioners, the following was concluded. Two main logics were found through which practitioners viewed the concept of cycle highways, its target group and consideration of the cyclist perspective. On the one hand, the car logic in which the cycle highway is to increase the competitive position of the bicycle as opposed to the car. Here, the focus lies mainly on tempting the currently non-cyclist commuter to make the switch by facilitating a fast, direct and efficient route. This rhetoric matches the assumptions of the conventional transport paradigm or design logic. On the contrary, the bicycle logic views the cycle highway as a development that responds to the needs of society and its cyclists. Here, the focus lies mainly on facilitating an optimal cycling experience for commuting cyclists in which the activity is valued. Subjective travel time and the role of an attractive route is considered important. This rhetoric matches the assumptions of the sustainable mobility paradigm or design logic. The eventual design is not only dependent on the logic that practitioners use to decide on the design of the cycle highway. Institutional factors such as the CROW guidelines, finances and stakeholders, but also physical factors have a major influence on the design. Especially due to the required adherence to strict standardized design guidelines the eventual design is often pushed to reflect the conventional design logic.

The current study shows that even though practitioners generally recognize the importance of the cyclist perspective, the design is often steered by certain guidelines into a conventional direction reflecting a car logic. Hence, this study argues for a reconsideration of the underlying design guidelines. More specifically, by allowing flexibility to area specific circumstances and by investigating and incorporating cycling experiences from various user groups. These insights are

highly relevant in a world where cycling innovations are considered key in acting upon some of society's most prominent challenges. Technological innovations such as the e-bike, speed pedelec and fitness trackers further indicate that there is great potential for infrastructural concepts such as the cycle highway to become successfully used. However, in line with other academic scholars, this study argues that successful cycling infrastructure requires practitioners to adopt a bicycle-oriented lens. In doing so, it is important to widen the scope from the non-cycling commuter to the wider population of current cyclists. This is also what has explicitly been brought to our attention in times of covid-19. Due to the pandemic, travel patterns have changed which point out that who cycles, why they cycle and how they experience it, is not as straightforward as the conventional rhetoric behind the cycle highway assumes. As was argued by scholars, the transition towards sustainable mobility starts with understanding the current cyclist, his or her experiences and needs in the cycling scene. This study has contributed to this call by exploring how different cyclist types and experiences are considered in the design of Dutch cycle highways. With that, adding to our understanding of top-down staging of this innovative type of cycling infrastructure. It also opens an avenue for future research to explore the bottom-up perspectives of different cyclist types and develop cyclist oriented assessment criteria for cycle highways. Such holistic understanding could further add to successful cycle highway designs and contribute to the sustainable mobility transition.

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Appendix A: Process Description

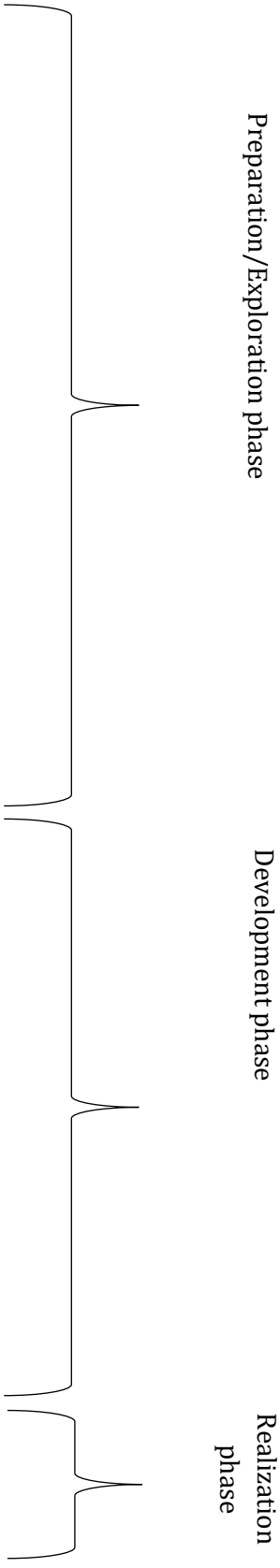
Steps (Fiets Filevrij, 2009)

1. **Exploration and start-up**
   - Getting stakeholders on board
   - Description of goals
   - Development of a vision
   - Current status of cycle routes in the area
   - Exploration of opportunities
2. **Inventory of routes**
   - Involvement of all stakeholders through participation sessions
   - Identification of local interests
   - Identification of necessary measures and wishes
   - Sketching possible routes
   - Cost estimates for the possible routes

   ➔ Preferred route(s), sketch design

   ➔ Decision on potential route(s) for next phase by administrative bodies
3. **Intention declaration**
   - Ensuring commitment by the parties for continuation of process
   - Intention declaration or board agreement
   - Subsidies can be applied for
4. **Elaboration cycle highway design**
   - Design elaboration of cycle highway from sketch design towards provisional designs and final designs
   - Detailed description of financial costs
   - Scope changes due to unforeseen circumstances
   - Feedback rounds with involved stakeholders to which adjustments to the design are made
   - Development of a realization plan

   ➔ Final design
5. **Signing general governance agreement or covenant**
   - Confirming financial agreements and measures to be implemented
6. **Realization**
   - Planning overview
   - Contracting procedures
7. **Opening**



Appendix B: Documents used in Analyses

Documents used in the document analysis:

Case study	Document reference
F50	Goudappel Coffeng. (2017). *Snelle fietsroute Apeldoorn – Epe: Potentieanalyse, routekeuze en schetsontwerp*. (Report No. SDD022/Adr/0116.01). Retrieved from https://vlotveiligfietsen.nl/images/Rapport_verkeer_Apeldoorn_Epe_SDD022.Adr.0116.01.pdf Clean Tech Regio. (2021b). Vlot en veilige fietsroute Apeldoorn-Vaassen-Epe. Retrieved from https://vlotveiligfietsen.nl/fietsroutes/vlotte-en-veilige-fietsroute-apeldoorn-epe
F35 Almelo-Borne	Goudappel Coffeng. (2019). *F35 Almelo – Borne: Onderzoek tracévarianten en uitwerking voorkeursvarianten*. (Report No. 00171820190222.R1.05). Retrieved from https://www.planviewer.nl/imro/files/NL.IMRO.0147.BpWNWZhz001-ow02/tb_NL.IMRO.0147.BpWNWZhz001-ow02_1.pdf ThuisraadRO (2018). Analyse belevingsaspecten op de F35 tussen Borne en Almelo. Regio Twente. (2014). *Masterplan Fietssnelweg F35: actualisatie 2013.* Retrieved from https://www.fietssnelwegf35.nl/inhoud/uploads/009-Fietssnelweg-F35-Masterplan-6-nov-14.pdf
Doorfietsroute IJsselstein – Utrecht	Provincie Utrecht. (2019). Intentieovereenkomst betreffende Snelfietsroute Utrecht-Nieuwegein-IJsselstein. Retrieved from https://geotest.provincie-utrecht.nl/publiek/AGO/snelfietsroutes/IntentieOvereenkomst/20190408_Intentieovereenkomst_U-N-IJ.pdf Provincie Utrecht. (2021, July 12). *Aanleg doorfietsroute Utrecht-Nieuwegein-IJsselstein kan van start* [Press release]. Retrieved from https://www.provincie-utrecht.nl/actueel/nieuws/aanleg-doorfietsroute-utrecht-nieuwegein-ijsselstein-kan-van-start Provincie Utrecht. (2021). Storymap snelfietsroutes: Snelfietsroute Utrecht-IJsselstein. Retrieved from https://utrecht.maps.arcgis.com/apps/MapSeries/index.html?appid=c749c67bf4334e8b97fc6fc698a31f95

Appendix C: Interview Guide

This research aims to explore to what extent and how different cyclist types and cyclist experiences are considered in the design of cycle highways in the Netherlands. Therefore, I am interviewing practitioners that are closely involved in cycle highway projects.

1. **Before recording:**
    - Informal introduction
    - Explanation of the research
    - Consent form / questions
    - Asking for recording permission

➔ Start recording

2. **Background Respondent:**
    - What is your professional role?
    - How would you describe your involvement in the design of cycle highways?
3. The cyclist from the practitioner's perspective

    Cyclist types
    - What are the expected people and uses for the cycle highway?
    - To what extent are these expected user(s) types guiding certain design considerations of the cycle highway?
        - And, how are these expected type(s) of cyclists considered in the design of the cycle highway?
        - Their needs? Are these assumptions? Or informed by the users themselves?

    Cyclist experience
    - How would you describe the ideal cycling experience?
    - To what extent is the quality of the cycling experience an important consideration of the cycle highway design?
    - Which aspects of cyclists' experiences are considered in the design of the cycle highway?
    - Do you also consider these experiences differently for different user groups?
        - How does this weigh in, in the design of the cycle highway?
4. **Design logic**
    - How would you define a cycle highway
    - Why do you think people would use the bicycle highway?
        - Are these assumed motivations also reflected in certain design considerations of the cycle highway?
    - How would you prioritize the following design considerations for cycle highways
        - Comfort, safety, attractiveness, directness, cohesion
        - Why in this particular order?
    - Could you fill in the following form? (see next page)
        - Do you feel like the current cycle highway project reflects these statement considerations?
            - Yes/No – how?
5. **Institutional aspects**
    - What institutional factors influence the design of the cycle highway?
        - How do they affect the design of the cycle highway?
            - Constraining vs enabling? (CROW, funding, actors involved)
6. **Ending interview**
    - Thank participant for their time. Tell them that they are welcome to reach out to ask questions at a later date if they wish.

➔ End recording

For each statement, put a cross on the line where you agree with the balance of the statements.

People in general	Try to minimize their physical effort regarding their mobility behavior	◆——————————◆	Regard physical effort in active mobility behavior, as something rewarding and stimulating
Travel time	Is a cost that should be minimized	◆——————————◆	Is not a cost, but should be reasonable
The cycle highway route should be	Straight and efficient	◆——————————◆	Not optimally efficient but focused on attractiveness
The cycle highway's purpose is	Fast movement of traffic from A to B	◆——————————◆	Providing an optimal cycling experience from A to B
Cycling from A to B is	A derived demand	◆——————————◆	A valued activity

Appendix D: Information Sheet Respondents

Thank you very much for taking the time to consider getting involved in my master thesis project.

This research explores the design logic behind the concept of Dutch cycle highways. The name "cycle highway" puts emphasis on providing fast and efficient routes, that seem strongly in line with the car-oriented way of thinking. However, several scholars have argued that cyclists have a distinctive and unique perspective that should be considered in planning cycling infrastructure. Consequently, the question emerges how cyclists are being considered in the design of cycle highways. This study will explore this through a multiple case study.

Confidentiality and participant rights

- The interviews will be audio-recorded and notes will be taken during the interview.
- You have the right to ask to have the recording turned off whenever you decide and you may also end the interview at any time.
- If you wish so you will be sent a copy of the interview notes, and you will have the opportunity to make corrections or request the erasure of any materials you do not wish to be used.
- The information you provide will be kept confidentially in a locked facility or in a password protected file on my computer up to five years upon completion of my research.
- The main use of the information you provide will help me towards my master thesis, which upon completion will publicly be available on Internet.
- The data may also be used for articles, book chapters, published and unpublished work and presentations.
- Unless you have given explicit permission to do so, personal names or any other information which would serve to identify you as an informant will not be included in this research or in any future publication or reports resulting from this project.

As a participant you have the right to:

- decline to participate;
- decline to answer any particular question;
- ask for the audio-recorder to be turned off at any time;
- end the interview at any time
- withdraw from the study up until the moment the research has been published;
- ask any questions about the study at any time during participation; and
- ask for the erasure of any materials you do not wish to be used in any reports of this study.

Once again I thank you for taking the time to find out more about my research. I am at your disposal for any questions you might have. You can also contact my supervisors at the address below

Researcher contact details:	Main supervisor contact details:
Emma Gerritsen	Femke Niekerk
e.m.gerritsen@student.rug.nl	f.niekerk@rug.nl

Appendix E: Agreement to Participate Form (Dutch)

Onderzoeker: Emma Gerritsen
E-mail: e.m.gerritsen@student.rug.nl
Telefoonnummer: Groningen, <datum>

Beste,

Bedankt dat u wil deelnemen aan een interview over de ontwerp logica van fietssnelwegen. Dit interview is onderdeel van mijn masteronderzoek voor de opleiding Sociale Planologie aan de Rijksuniversiteit Groningen. Voor mijn masteronderzoek ben ik geïnteresseerd in uw perspectief op het ontwerp van fietssnelwegen en de overwegingen welke daar bij komen kijken. Door middel van dit interview, zou ik hier graag meer te weten over willen komen.

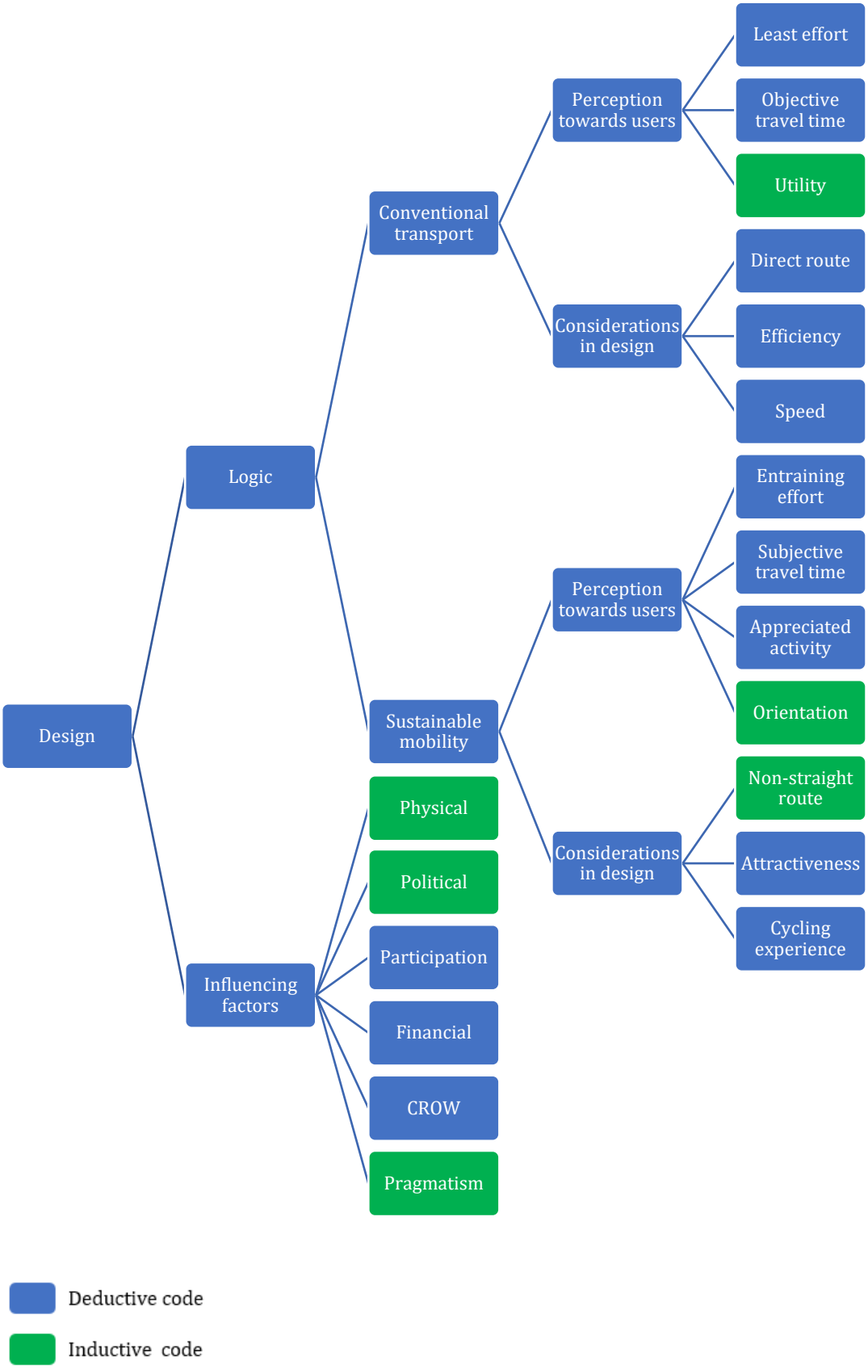
Door dit toestemmingsformulier te ondertekenen, gaat u akkoord met de onderstaande punten:

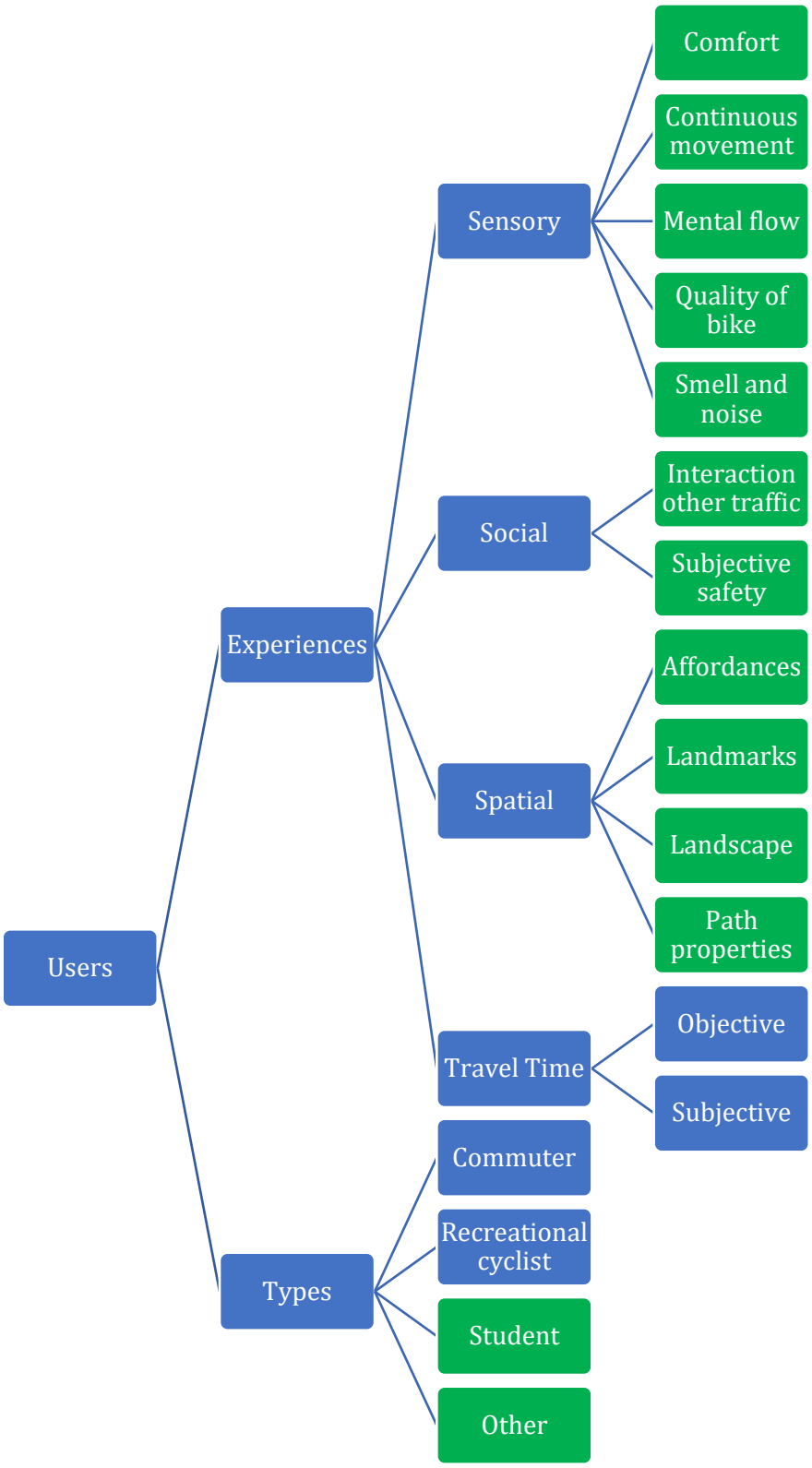
- Ik ga akkoord met deelname aan het interview en de onderzoeker heeft het onderwerp van het onderzoek uitgelegd.
- Ik ben ervan op de hoogte dat het interview volledig vrijwillig is en dat ik op ieder moment het interview kan beëindigen of onderbreken.
- Ik ben ervan op de hoogte dat ik er altijd voor kan kiezen om een vraag niet te beantwoorden.
- Ik ben ervan op de hoogte dat mijn antwoorden vertrouwelijk zijn en dat mijn naam niet genoemd of gekoppeld wordt aan het onderzoek zonder mijn toestemming.
- Ik ga ermee akkoord dat er een geluidsopname van het interview wordt gemaakt en dat niemand, behalve de onderzoeker, toegang heeft tot de geluidsopname van het interview zonder mijn toestemming.
- Ik ben ervan op de hoogte dat ik een schriftelijke versie van het interview kan inzien.
- Ik ga ermee akkoord dat het interview geanalyseerd en gebruikt wordt voor het onderzoek.
- Ik ben ervan op de hoogte dat ik een versie van het onderzoek bij de onderzoeker kan opvragen. Daarnaast ben ik ervan op de hoogte dat het onderzoek is in te zien voor studenten en medewerkers van de Rijksuniversiteit Groningen.

Datum: *Naam en handtekening geïnterviewde:*

Datum: *Naam en handtekening onderzoeker:*

Appendix F: Coding Trees




Users
Experiences
Types
Sensory
Social
Spatial
Travel Time
Comfort
Continuous movement
Mental flow
Quality of bike
Smell and noise
Interaction other traffic
Subjective safety
Affordances
Landmarks
Landscape
Path properties
Objective
Subjective
Commuter
Recreational cyclist
Student
Other
Deductive code
Inductive code