

Michael Dyblie

## Planning for recreational cycling:

Exploring a flow-based framework for  
placemaking and urban vitality in Zwolle, the  
Netherlands

Graduate thesis in Urban Ecological Planning (UEP)  
Supervisor: Mrudhula Koshy  
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## Prologue\Preface

This master's Thesis explores the possibility of developing a framework relating Csikszentmihalyi's concept of flow & recreational cycling, for the purpose of improving cycle routes. These proof-of-concept trials took place in Zwolle, the Netherlands with the help of a mobility company based out of Delft, where the author undertook an internship from August 2022 until June 2023, primarily focused on the endeavours relevant to this project. My interest in cycling as a mode of transportation, stemmed both from by my general curiosity and educational background as a student of urban planning and international development, helped to motivate me to want to pursue a thesis in a related topic. So when this internship proposed to me that I take the lead on this project, I was intrigued, and decided to take it on as my thesis topic.

The trials utilized a mixed-methods approach, combining sensor data, with standard video footage of participant reactions and course data from a 360° camera, as well as surveys and an interactive interview with participants after the ride. Furthermore, expert interviews were also be conducted to provide more context and robustness to the current understanding of flow within planning and related fields.

## Executive Summary

This work is a «internship-based» thesis that explores the interrelations between Csikszentmihalyi's concept of flow and recreational cycling to improve cycle routes. The research was conducted in Zwolle, the Netherlands, in collaboration with the Dutch mobility company, Mobycon. The study employed a mixed-methods approach, combining sensor data, video footage, surveys, and interviews to investigate factors influencing flow experiences during cycling journeys. Expert interviews were conducted beforehand to enhance the understanding of flow within planning and related fields, as well as to make adjustments to the method before embarking on the trials.

The primary research question focused on how exploring the interrelations between flow, placemaking, and urban vitality may contribute to improving recreational cycling planning. The sub-questions explore the interactions between placemaking and urban vitality, the potentials and limitations of flow, and the applicability of mixed methods in enhancing cycling planning.

Based on the results and discussions, several conclusions can be drawn. Designing cycling routes that prioritize aesthetic appeal, safety, and opportunities for social interaction can promote flow experiences. Safety steps, like segregated paths and traffic calming measure, are crucial in minimizing interactions with motorized vehicles. Creating stopping points and points-of-interest along the routes encourages socialization and contributes to the sense of vitality, thereby fostering a sense of place.

The study suggests that the CROW principles, adapted to the context of recreational cycling, should guide planning efforts, prioritizing safety, attractiveness, and coherence. Placemaking and urban vitality concepts offer valuable insights to enhance recreational cycling by treating routes as quality spaces and incorporating diverse elements. Understanding and facilitating flow experiences can enhance the positive emotional states of cyclists, but it should be acknowledged that other emotional states, such as relaxation, are also important in route planning.

The implications for planning and design of recreational cycling environments include adapting and applying the CROW principles to a recreational context. Thereby, prioritizing diverse and engaging experiences over directness. Planners should consider incorporating layered architectural and natural elements, emphasising safety, and providing opportunities for social interaction. By integrating flow, placemaking, and urban vitality, planners can create environments that enhance the overall quality of the recreational cycling experience.

In conclusion, this thesis highlights the potential of flow to interrelate with placemaking and urban vitality consequently enhancing the recreational cycling planning process. The findings provide valuable insights for planners and designers to create cycling routes that promote flow experiences, prioritize safety, encourage social interaction, and enhance the overall quality of the cycling environment.

## Statement of Authorship

*I certify that this is my own work. These materials have not been published before, nor Presented in any other module, or programme. Due acknowledgements has been given to the knowledge, ideas and words of others have been drawn upon, whether from published or unpublished sources. I understand that the normal consequence of cheating in any element of an examination or assessment, if proven, is that the thesis may be assessed as failed.*

Date: 04-07-2023

Signature of author:

X 

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Michael Dyblie



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Key terms: Flow, Flow State, Placemaking, Vitality, Electrodermal Activity (EDA), CROW Principles

Secondary Terms: Emotibit, Skin conductance level (SCL), Skin conductance response (SRC), Microsiemens ( $\mu$ S), Place identity

## 1 Introduction

The places we choose to live, work, and spend our time are important facets influencing how we think, feel, and live our lives. Equally important, is how get from place to place. The way we choose to move through cities and the countryside has potentially profound impacts on our health and wellbeing, as well as those around us, and the planet at large. Throughout the course of the 20<sup>th</sup> century the automobile began to be seen as the preeminent way to get around our cities and places (Melosi, 2005). The field of urban planning at this time, was profoundly influence by this trend, developing a vision for the future centred around the automobile (Jacobs, 1961). Car-oriented infrastructure and by consequence, car-oriented spaces became the norm across the globe (Saeidizand, Fransen and Boussauw, 2021). Yet now, this paradigm is beginning to shift as people across the globe are recognizing the negative implications that come with developing urban places and lived spaces around the car. Noise, traffic, stress, an ever-present danger to other vulnerable road users, a big contributing factor to carbon emissions, and therefore the climate crises, the intense use of automobiles poses problems both locally and globally (Moss, 2015). More and more individuals across the globe are beginning to realize this and by consequence, are demanding a shift to more sustainable forms of travel, whether that be public transit, foot, or what is to be the focus of this master's thesis, the bicycle, particularly in this case, recreational cycling. Yet, just as the way we get from place-to-place matters, so does the built environment *between* these places matter. If we as citizens and planners want people to choose to go out for a walk or take their bikes out more often, the environment in which they do said activities should be friendly, inviting, enticing, exciting and *vital*, in order to make individuals want to do so. Getting to the root of these positive associations that people may have with certain aspects of their environment, is what this thesis hopes to explore, particularly as it relates to their experience of the outside world on two wheels.

This internship-based thesis will explore the interrelations between urban planning and psychology using the theoretical concept of `flow` as first postulated by Mihaly Csikszentmihalyi (1975) and how, it could potentially be applied to the context of recreational cycle path development for enhanced urban vitality and placemaking. With the assistance and resources provided by the mobility promotion consultancy company, Mobycon, participant cycle trials were conducted across six days from April to early May 2023 in Zwolle, The Netherlands, to demonstrate what, if any relationship can be established between the ability to attain a state of flow, the vitality, and placemaking aspects of a recreational cycling route. The context of conducting said trials in the Netherlands is important to note, as this country is considered one of the most preeminent cycling nations in the world. More than a quarter (28%) of all trips within the country are made primarily by bicycle (De Haas and Hamersma, 2020). This is likely in part due to the 35,000 km of dedicated cycle track that has since been laid out, equal to about a quarter of the entire country's road network (CROW Fietsberaad, 2014). Such data is important to consider, as relative to other contexts around the world, the Netherlands has made significant strides to reduce potential impediments of the built environment, and therefore encourages cycling as a useful transportation mode. Such a context is very relevant for research to move beyond concerns over what in the environment might leave potential cyclists with negative associations imprinted in their psyche, and instead can focus on what elements bring about positive associations, through the creation of a sense of place, that brings about vibrancy and vitality to a route. Hence the Netherlands, could be seen as an ideal context to demonstrate if any correlations can be established between Csikszentmihalyi's flow theory and the vitality and placemaking aspects of a recreational cycle route that may allow participants to experience such a flow state.

A good deal of scientific literature has been produced analysing which factors contribute most to the experience of negative emotions while cycling, such as the paper *Infrastructures through*

*Intersubjectivity of Stress Sensations Derived from Physiological Measurements* by Christian Werner, Bernd Resch, and Martin Loidl (2019), among others. Yet, comparatively little research has been conducted into what factors enhance positive emotions during cycling trips. Furthermore, limited connections in academic literature have been made between urban planning and flow theory. This has typically been done through a dense and theory intensive lens such as the work by Filipa Matos Wunderlich (2013) *Place-Temporality and Urban Place-Rhythms in Urban Analysis and Design: An Aesthetic Akin to Music* through which an argument is made connecting Csikszentmihalyi's study of flow, to flow being an attribute of unique temporary places. In other words, the case is made that urban place temporality is experienced as flow. Similar such work has tended to focus on said connection with place temporality. Yet, the connection to the subfield of transport planning is just beginning to be explored within the last year (Te Brömmelstroet et al. 2021). More detail will be mentioned on this below. Keeping all this in mind, this thesis will take a deeper look into exploring these gaps by attempting to develop a functional framework to measure this experience of flow in travel scenarios, and exploring the relations it may have to urban vitality and placemaking as a means to contribute to better planning for recreational cycling.

This thesis is a combination of my personal goals and the organisational goals of Mobycon, made to fit with the requirements of an urban ecological planning (UEP) thesis. Assuming any concrete results can be extrapolated from this experiment, the framework could potentially be utilized as an approach to further enhance and fine-tune the development of recreational cycling networks. In case of Mobycon and its partners, the purpose of conducting such trials is two pronged. First, to see if a functional and repeatable methodology can be developed based on their resources and the stipulated timeframe. Then, assuming such a methodology can be developed, the hope is that it can be utilised in a large project in Denmark to develop a national recreational cycle network in which Mobycon is one of the partners.

In theory, routes could thereby be more carefully selected to enhance user fulfilment in addition to conventionally more pressing concerns such as that of user safety or minimizing user stress. Rather than just create pathways that are safe and low stress, but run the risk of being perceived as boring, routes could be better curated for factors like engagement, enjoyment, and presence and recreation. Thereby theories regarding placemaking and urban vitality will also be compared and explored to be used as supporting theoretical frameworks, for this master's thesis. Particularly, ideas of nature-based placemaking and cycling as an urban vitality tool will be examined in greater detail. How such theoretical frameworks may coincide, and work in tangent with flow theory as route enhancement tools will be discussed in greater detail in the 3<sup>rd</sup> chapter.

This experiment will involve the use of a mixed-methods approach combining data from wearable devices (particularly looking at the electrodermal activity (EDA) data), video footage of the route and participants' facial expressions, surveys, and reflection interviews with participants as well as expert interviews to further support these trials. The details regarding how this shall be done will be thoroughly elaborated on within the methodology chapter.

It will be important to highlight that this thesis is not referring to the conventional traffic engineering perspective of flow, ever-present in mobility and urban planning literature (Lieu, 1999) (Though it could potentially play a role as a factor in the research, it will not be the primary concern). Therefore, a more fleshed out, clearly defined definition of flow that combines perspectives from psychology, mobility, and urban planning literature shall be put forth in the theoretical framework.

One such article that will be examined is *Optimal Experience and Personal Growth: Flow and the Consolidation Place Identity* (Bonaiuto et al., 2016). This work in a round-about way establishes connections between flow theory and placemaking, but through a psychological lens using instead,

the concept of place identity. Through this analysis, reflections can be made as to what attributes presently ascribed to the flow concept could best be utilized to develop a definition of flow, that is appropriate and measurable in mobility research. Furthermore, when combined with the above-mentioned perspectives on placemaking and urban vitality, a more nuanced understanding of flow and its potential contribution to the urban planning field, may be attained.

The work connecting this concept to mobility research has only recently begun with publications like *Have a good trip! expanding our concepts of the quality of everyday travelling with flow theory* written by Marco te Brömmelstroet et al. (2021). As that paper seemed to suggest, cycling was one of the modes of transportation in which individuals were most likely to experience flow.

This thesis seeks to explore why that may be the case, and if it would be possible, through the improved utilization of methods, to identify what factors present within a cycling journey, like exercise intensity, weather, quality of infrastructure, quality of scenery, topography, degree of greenery, perceived safety, etc., (Te Brömmelstroet et al., 2021) that enhance or take individuals out of a sense of flow.

The trials took place in April and early May, based out of the Mobycon in Zwolle, the Netherlands. This April was a particularly rainy one, thus the impact that such weather had on the results was felt, giving us a good contrast to compare with the sunnier trial dates.

With the above notions in mind a primary research question and complementary sub questions have been developed for the purpose of this UEP master's thesis:

**Main Question:**

*How can exploring the inter-relations between the psychological concept of flow with that of placemaking and urban vitality, contribute towards improving planning for recreational cycling?*

**Sub Questions:**

*In what ways can understandings of planning concepts like placemaking and urban vitality contribute to enhancing recreational cycling?*

*What are the potentials and limitations of the concept of flow regarding improving planning for recreational cycling?*

*In what ways could a mixed methods approach contribute to using the concept of flow in improving planning for recreational cycling? How may this be done in a manner that is both reliable and repeatable, for the purposes of future use and research?*

## 1.1 The Project and the Internship: A Summary

Since starting the Urban Ecological Planning master's program and learning about the different styles of master's proposals that we could choose from, my tendency was to be drawn to the internship-based proposal. My reasoning behind this is that I wanted my thesis to have some sort of tangible, real-world impact, for the results to be utilized and expanded upon. Seeing that this project itself is attached to a much larger effort happening in Denmark, where Mobycon together with several other companies are consulting on an effort to develop a national recreational cycle network, it appeared to me to be an ideal scenario for the work of my thesis, to be a building block for further research. It may even help to improve the way that recreational cycle routes are chosen and designed within Denmark, which is a very exciting prospect in and of itself.

With the above in mind, I have nonetheless hoped, strived, and worked towards the goal of developing a master's thesis that will add value to the fields of urban planning and mobility; a thesis that can serve as a foundation, a launching point for future work to come. The motivation for this goal is at the least, two-pronged, deriving from my experiences growing up in the United States, and the host of new learning and perspectives that I have been introduced to while attending the UEP program.

Growing up in the suburbs of North County San Diego, California, life at times, seemed like the happening between one car journey and another. Over the course of half a century, a beautiful natural landscape has carved up into islands of the suburban form, so standardized and commonplace as if it could be anywhere else in the USA or Canada. In my formative years, this sentiment was best state by the late comedian George Carlin, when he declared:

“ Only a nation of unenlightened half-wits could have taken this beautiful place and turned it into what it is today: a shopping mall... That's all you got here, folks. Mile after mile of mall after mall. Many, many malls. Major malls and mini malls. They put the mini malls in between the major malls, and in between the mini malls they put the mini marts. And in between the mini marts [you] got the car lots, gas stations, muffler shops, Laundromats, cheap hotels, fast food joints, strip clubs, and dirty bookstores. America the Beautiful: one big transcontinental, commercial cesspool. ” (Carlin, 2011).

Reflecting on my own such experience, I recognize that one of the linking factors contributing to the formation of such a landscape is the automobile (Akhtar, 2022). All these generic, copy-paste stores are built for and around the use of cars. In the United States, the car is seen as a symbol of freedom (Sovacool and Axsen, 2018), and to certain extent this makes sense, as in much of the country you are hardly able to go anywhere without one. But is this even freedom? As the urbanist youtuber, Adam Something (2023), declared in one his videos: “If cars are the only option, you don't have freedom. You have mandatory microtransactions forced on you by the auto and oil industry.” With said option being so dominant, it is no wonder that while growing up almost no one seemed to be talking about freedom from the automobile, let alone other ideas like transport poverty, walkability, bike-ability, the 15-minute city and other concepts (cbraun@esf.org, 2023; Schauenberg, 2023; US Green Building Council, 2023).

I have always had a fascination with cities, I was not fully aware of the existence of the discipline of urban planning until sometime into my college years. Therefore, it was not until then that I realised this a field of study that could not only see myself pursuing, but thriving in.

This led me to my pursuit of finding a suitable master's program to start to expand my expertise and qualifications in the field.

I applied to several master's programs across Europe, that drew me in, ultimately choosing to begin the Urban Ecological Planning program at NTNU, amid the hectic Covid-19 pandemic. I was drawn to this program in large part due to its focus on participatory, inclusive, and developmental planning practices (NTNU, 2018), which in a certain respect built off some of the ideas I was exposed to my Global Studies bachelors, but in a manner that felt more tangible. Furthermore, the prioritizations of the learn-by-doing-approach, (otherwise known as experiential learning, first postulated by John Dewey in (1916) where pupils learn through replicating and repeating the task or process themselves), in teams multidisciplinary and international teams, made for the idea kind of practice ground, that I was seeking to jump start my future career.

My time in the UEP program, helped me to understand how complex concepts could be interlinked theoretically and methodologically for the purposed of enhancing urban environments and sustainable mobility endeavours. One of the most prominent examples of this for me were the



debates around the formal/informal divide. I thought it was so fascinating that the program gave light to some of the potential benefits that informality may bring to an urban context, and the potential downsides of an overly formal landscape, such as rigidity. Normally in the Western context slums, favellas, and other forms of informal places are seen with a negative light. And while there is still plenty to be critical about regarding such urban forms, like sanitation standards, and safety (especially from a contingency planning perspective), it was refreshing to be exposed to new narratives, that challenged such preconceive assumptions. Even the above example of informality could be considered too narrow of a definition, as one might make the argument that many of Europe's old towns, often built in the medieval era, are examples of organic, informal development. Today, such areas tend to make up some of the most visited and cherished areas of town due to their charm, layered complexity often lacking in today's formal, masterplans. I bring up such an example to speculate and ponder, if said layered complexity to a space may be more likely to keep one in a sense of presence, or in other words a *flow state*.

With all that in mind, I began from the first semester to look around and take note of what companies and organizations, were doing work in the field that appeared, to be impactful, piqued my interest, and offered internships during a timeframe that aligned with my thesis timeframe.

## 1.2 Internship: Background & Motivation

So, one may ask, why the focus on cycling? And why in the Netherlands? According to a recent study (Chen et al., 2022), if the global population was to cycle as much as the Dutch do, emissions would be able to be cut by nearly 700 million metric tons of carbon dioxide every year. Such a figure is almost equivalent to total emissions of Germany. Even if everyone in the world cycled just one mile per day (2.6 kilometres), global emissions of carbon dioxide could be cut by 414 million metric tons (One Green Planet, 2023).

As the cycling advocacy channel, BicycleDutch (2019) explains, cycling has a lot of other net benefits to society. The annual costs of using and maintaining a bicycle is about €300, whereas for driving a car one can expect operating costs of about €8,500 in the case of the Netherlands (Hendriksen & Giljswijk, 2010). Furthermore 1 kilometre cycled yield a social benefit of 68 Euro cents, whereas 1 kilometre by bus cost costs 29 cents, and cars cost society 37 cents for the same distance travel (Deciso, 2016).

Cycling also helps to benefit the local economy. Despite the tendency for cyclists to spend less per trip, they spend more overall in local shops, since they shop more often than automobile users (Deciso, 2017).

A bicycle's life cycle tends generates minimal carbon emissions (European Cyclists' Federation, 2016). When people switch from cars to bicycles, this also drastically helps to improve local air quality, with a reduction of 65% NOx per kilometre travelled (Harms & Kansen, 2018).

Additionally, cars create a huge spatial issue for cities, taking up an enormous amount of space. In the most extreme of cases, such as in countries in North America, many downtowns devote as much as 50 to 60 percent of their real estate to vehicles (Plumer, 2016). When cities can switch even a portion of their car commuters over to cycling, this presents an opportunity. Public space can thereby be improved by turning car space into people space, improving the local environment (Institute of Transport Studies et al., 2010). A great example of such a project is the transformation of the area near Utrecht Centraal station. This area was once part of a historic canal but was filled in to make way

for a motorway in 1969. Yet after some decades the city began to realize their mistake, with the city council finally deciding to restore the historic city moat back in 1999 (BicycleDutch, 2016). However, it took until 2020 for the canal to be fully restored and open to the public (Arquitectura Viva, 2022).



Figure 1. Utrecht Canal before and after restoration project. Source: Leaf of Life YouTube Channel 2023

With such solutions, traffic noise is also reduced, as high decibel motor vehicles are replaced with the comparatively silent bicycle and more public space. Riding a bike also serves as a healthy, low-impact form of exercise for all ages. Cycling regularly is purported to boost physical fitness, with 30 minutes per day being equivalent to the weekly recommended level of physical activity. Life expectancy prolongs by an estimated 3 to 14 months (De Hartog et al., 2010). This in part, may be attributed to the reduction of risk the activity is reported to have on serious diseases and depression: 40% less for Cancer, 52% less for heart diseases and over 40% less for Premature death (Nijland, 2017).

Furthermore, and perhaps what is most relevant for this master's thesis, is that cycling is seen by many as an activity that makes one happy. According to a study in the Netherlands, up to 59% of all cyclists associate cycling with joy while only 2% dislike the activity (Harms et al., 2017). As it pointed out in the same study, this is likely because cycling is also associated with convenience, independence, flexibility and punctuality. Thereby, cycling fosters a sense of improving one's quality of life.

Such facts, as those listed above motivated me to begin applying for internship positions in the Netherlands during my second semester of the master programme. As previously stated, Mobycon is a mobility promotion consulting company, whose focus is on the redesign of streetscapes to a more people-focused and cycle-friendly typology as well as on the education and promotion of said ideas to the public and city officials. Mobycon has worked on projects all over the world from Latin America to Africa and had a particularly active presence across Europe and North America, with offices on both continents. This is a company that has worked in a variety of urban and cultural contexts, adjusting their principles to whatever happened to be the given context at the time, whether that be a project in the company's home country of the Netherlands, or somewhere different. This was the sort of company that I undoubtedly felt had both a breadth and depth of experience that could teach me about the realities of working within the international urban mobility consulting world. Considering Mobycon already had a tangible impact on me, through following the work of some of their associates,

it seemed like a fitting choice for me to give back tangible benefit to them, as well as develop a master's thesis would have a real-world use-case.

## 2 Methodology and Methods

The aim of this section is to explain the research methodology that was adopted to answer the research questions and uncover my findings. The methodology is the general approach I followed to answer my research questions. This is different from the methods, which are the tools and techniques that were utilised to derive my findings (Yin, 2014).

The methodology utilised to answer my research question is a mix-methods approach in which participatory trials were conducted in Zwolle, Netherlands over a route with a diverse set of characteristics (from urban to rural, and a range of different cycle-riding surfaces) to see if Flow may be reliably detected within the Dutch context. A thorough analysis of the existing literature, on the topics of psychological flow, the use of measurable devices in cycling research, urban vitality, placemaking, and how said topics have and can potentially interrelated to each other, helped to provide further background information for these trial runs. This exploration of interrelations can be found in the *Theoretical Framework* chapter, in which this data was analysed via qualitative content analysis (Hollweck, 2016).

A total of four expert interviews were also conducted to better understand what ongoing research be conducted regarding the topics of 'flow', cycling, wearable devices, urban vitality placemaking, and related disciplines. This helped to provide further context to keep in mind, when going into these proof-of-concept trials. Such context at times was also utilised to adjust the trial development, methods, steps, etc.

Hence, for these flow trials, and the broader research behind it, supporting and building a framework for this master's thesis, a mix of both quantitative and qualitative research strategies were used.

In the case of the internship section of this project, I was primarily responsible for the development of the flow trials and the methods that were utilised. Presented below is a of vision of the trials, that demonstrated the development and process utilised.

### 2.1 Flow Experiment Logistical Preparations

In order for myself and the fellow Mobycon colleagues assisting me on this project to ready for these flow trials, a whole host of logistical preparations had to be made. There were several meetings around this to discuss timelines, materials, costs, etc. One tool that I used to help organize and visualize all that needed to be done before the first day of trials (and beyond, into the data analysis) was a gantt chart. This helped me and colleagues, to better stick to self-imposed deadlines, and better itemize all the tasks that needed to be done. This ensured that we had the necessary materials ordered, coding preparations completed, and invitations sent out in preparation for the first round of trials.

## Flow Trial Preparation Plan

Mobycon

Project Lead: Lennart Nout

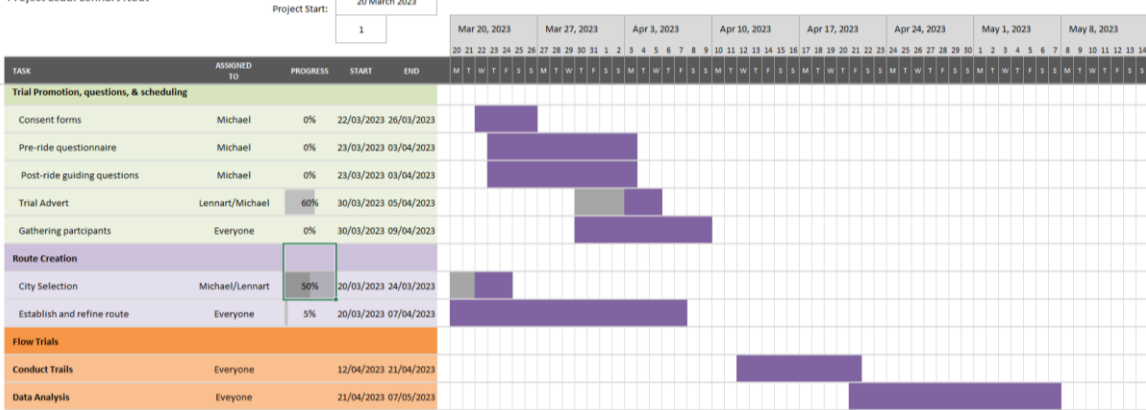


Figure 2. Gantt Chart used to organise trial preparation timeline. Source: Author

An example of the list of equipment is demonstrated below in the Appendices section. It was made in collaboration with colleagues, where I listed all the items we needed or thought we may need for the trials. The list included the items in question, links to where they could be purchased, and the estimated cost of the respective items in question. My colleagues provided feedback then as to what items, we needed to order and what items we already had available to us.

A logistical breakdown of the trials themselves and the necessary preparation steps was also made for me and my colleagues to better conceptualize, what needed to be done before and during the trials to ensure a relatively smooth procedure.

### 2.1.1 Vision & Logistical Preparations for Flow Experiment

1. All necessary items, in preparation for the trials, had to be ordered.
  - a. Items with the longest potential shipping window and priority items such as the EDA (Emotibit) sensor and additional camera equipment were prioritized.
2. The explanation procedure, the pre- and post- ride survey questions, as well as interactive interview guiding questions, were developed in preparation for the trials.
3. Participants were recruited through, word of mouth, the Mobycon network of colleagues and friends, LinkedIn posts, and through a presentation at a local school in attempt to garner a diverse sample consisting of for instance, a diverse swat of age ranges, genders, and bicycle experience, etc.
  - a. Participants were directed to a Calendly link, to sign-up for a time slot.
    - i) This link included a set of 7 questions, to derive an autotelic personality score. This is a method that has been used frequently to derive an individual's proclivity to entering the flow state. *More on this in the section below, in the results, and the appendices.*
    - b. *\*It should be noted that, despite the attempted recruitment, the age sample did not end up being very diverse (highly skewed toward the younger age range). More on this in the results section.*
4. Participants started each trail by first getting an overview of the aims of this experiment followed by a brief explanation of what they are tasked with doing.

5. Participants answered a set of mood & cycling-related survey questions before the ride, to get a sense of their state of mind and level of cycling experience going into the ride.
6. Participants were assisted on putting on the wearable EDA sensor, before embarking on the ride.
  - a. For a majority of trials (with the exception of one) the sensor was placed on the left wrist.
    - i) For the first trial day, dry electrodes that came with the sensor were used.
    - ii) For all other subsequent trial days, wet electrodes were used. The switch was made as data results proved far more consistent, and with less obvious errors, than with the dry electrodes or other attempted methods.
      - (1) Wet electrodes had to be cut with scissors in a manner to fit the placement of under sensor, on the participants' left wrist. This potentially has some impact on the results, but nothing that was seemingly detectable.
7. A sensor check was made to ensure the device was recording, it had adequate battery, and reasonable readings could be detected on the data visualiser software before embarking participants on the journey.
8. Participants were shown and explained the course map.
  - a. While the route itself was designed with the intention of being relatively straightforward to follow, participants were nonetheless encouraged to take a picture of said map, just in case of any confusion.
    - i) *Despite this, two participants still ended up getting lost, but this may have been more the researcher's (myself) fault more than that of the participants. More on this in the result/discussion section.*
9. Participants were escorted to the bike. The seat was adjusted according to the participant's height, and the camera was mounted and adjusted accordingly.
  - a. Once all adjustments were made the camera was turned on and recording was begun with a shot of the live timestamp from the researcher's phone, before embarking the participants on their journey.
10. Participants began the ride.
  - a. The track was marked with high visibility painted arrows, indicating the intended route.
11. Upon completion of the route participants were given a series of survey questions on a tablet to reflect upon the bicycle ride they had just embarked on; reflecting and any potential moments-of-flow they may have experienced, and/or the factors that may have encouraged, prevented, lead into, or took them out of such perceptual experiences.
12. After survey completion a brief recorded (with consent of the participant) conversation was had with participants and the researcher (myself), utilizing the video footage and EDA data from the Emotibit sensor, to further reflect upon the experience.
13. Results from the survey, questionnaire, and after-ride reflections were then cross-examined and analysed together with data from the EDA (and possibly other factors') sensors, and the video footage.
14. The findings of this mix-methods approach were then extrapolated, the accuracy of the findings was weighed. More on this will be discussed in the results section.

## 2.2 Expert Interviews

In total, four interviews were conducted. Expert 1 had an expertise primarily in mobility. They were somewhat familiar with the concept of flow, but not extensively. Expert 2 had vast expertise in planning, mobility, and has worked extensively to imagine how Flow theory may be better incorporated into cycle planning. Expert 3 has an expertise in the various wearables and other technologies, that are increasingly being incorporated into cycling research and day-to-day use. They were quite familiar with the concept of flow and were particularly interesting to talk to in terms of deducing ways that measurable devices might be used to measure or determine when someone was in a state of flow. Expert 4 was a fellow master's student also doing their thesis on a topic regarding flow and cycling. In their case, the focus is more on group flow on elderly populations. It was valuable to talk to someone else also working to find a way to measure flow in cycling, and to compare and contrast our different methods and focuses. Hence, a fresh range of perspectives was able to be gathered on how Flow theory may be able to connect and contribute to placemaking and urban vitality within this context of recreational cycling. Email information was exchanged as a means to contact said experts, but none of this personal data will be saved once the Thesis is complete, and participants' right to revoke the use of their data will of course be respected, and thereby not included in the results.

## 2.3 Overview of Survey questions

Below is a brief overview of the various questions categories asked of the trial participants and the motivations behind each. In some cases information, like participants' emails or phone numbers were collected as a means of contacting participants and sending them information regarding the trial date, time, and location. None of this personal data will be saved once the Thesis is complete, and participants' right to revoke the use of their data will of course be respected, and thereby not included in the results.

### 2.3.1 Autotelic personality Questions

These questions were posed to participants during the sign-up process. An autotelic individual is defined as one who has an initiate sense of purpose (Heilala, 2022). Those with more autotelic personality traits tend to have an easier time entering a state of flow, and hence such questionnaires have often been used to measure individual's proclivity to flow (Tse et al., 2018; Nakamura & Csikszentmihalyi 2002).

The motivation to include such questions into this research, stemmed from that idea, that if we can have some sense of an individual's proclivity to entering the Flow state, we can use that data as a kind of corrective mechanism to better understand if said individuals experienced Flow because of certain environmental factors of the course, or simply because they were already prone to do so.

These questions were derived from the 26 question Autotelic personality questionnaire (Heilala, 2022). These 26 questions are often further broken down into the following categories, that represent different components of the autotelic personality matrix. These are the following as shown in the table below:

Table 1. Autotelic questionnaire personality assessment instrument content Source: Heielala (2022)

<b>Substructure definition</b>	<b>Abbr.</b>	<b>Associated functions</b>
Curiosity	CU	Expressing enjoyment for life through interest
Persistence	PE	A strong passion transcends goals with lasting perseverance
Low Self-centeredness	LS	Narcissistic lifestyle reflects a loss of achieving mastery
Intrinsic Motivation	IM	Enjoys achieving despite external premia, for their own sake
Enjoyment and transformation of Challenge	EC	Menacing positions arranged into a pleasant achievement
Enjoyment and transformation of Boredom	EB	Free forming exciting monotonic features into enjoyment
Attentional Control	AC	Plasticity to absorption that resists schizophrenic helplessness

To make it simpler for the participant sign-up process, I simple chose to go with a question from each of these categories, that appear most relevant to context of recreational cycling, making for 7 autotelic questions in total. This may not have been the best method to employ in terms of reliability levels, (as some of these question categories appear to display better reliability than others, as is described in Heielala’s (2022) paper but seeing as how for our purposes, we just want to get a general idea of participants’ proclivity to enter flow, this should be good enough for our purposes. Each question was asked based on a 7-point scale (Strongly Disagree = 1, Strongly Agree = 7). The first six questions are positively scored, with the last question, from the attentional control category, being reversed scored. Participants with a higher total score, can be assumed for our purposes to have a higher proclivity to enter flow.

### 2.3.2 Pre-ride questions

These questions were asked, of participants the day of the trials before embarking on the cycle ride. These questions ranged from general demographic information, mood coming into the trial day, level of cycling experience, and cycling preferences.

### 2.3.3 post-ride questions

The questions were asked just after the cycling trip, once participants were back in the office. This allowed participants to freshly reflect on their experience, while giving myself time to upload the camera, and sensor data on the computer, and plug that said data into the python terminal, that my colleague developed especially for these trials. This data analysis of this overall survey will be discussed more in the results section.



## 2.4 Guiding questions for interactive interviews

Before beginning the interactive interviews, data from the camera and the Emotibit were first uploaded to computer used for these trials. The Emotibit data had to be run through a data parser that came as part of the Emotibit software package. Then the necessary data could be plugged into the python terminal, to display the data graph from the given participant's ride. This data was paired with the accompanying video, and an interactive map of the course that participants and the researcher could use to zoom in and out, thus highlighting certain areas of the course, or moments of the experience. Once all these steps were completed, the interactive interviews could begin. These interviews were recorded with the consent of participants as a means to be able to listen back to analyse their results further. None of this data will be saved once the Thesis is complete, and participants' right to revoke the use of their data will of course be respected, and thereby not included in the results.

These questions, which can be seen in Appendix F, were used only as a loose guide to navigate this more relaxed, interactive, conversational style interview conducted with each participant. This loose structure was done intentionally so that the researcher could better curtail and personalize questions to each participant, to better uncover the details of various aspects of their experience, and how that may have aligned to the sensor data and the perceived mood on their faces seen on the video recordings. Furthermore, the sensor did not always produce usable data, at least in the first round of trials. Occasionally some challenges were also encountered displaying the video footage to participants. So contingency plans were put into place, where those interviews were conducted using only the accompanying course maps, and whatever other data that was available, be it the video footage or EDA chart. More details regarding this will be documented in the results section.

## 2.5 Necessary equipment, software & procedures

Critical to the attempt to develop a mixed methods approach with these participatory trials, was the necessary equipment to help capture our sources of quantitative data and to assist with some aspects of the qualitative data. The two sources responsible for quantitative data capture were the Emotibit sensor and Insta360 camera that I shall describe in more detail below. Other equipment and software that was needed for the procedure included: a computer (in this case a Macbook Pro was used) loaded with the Emotibit software package, Python, the necessary python libraries, and code that my colleagues wrote for the process, an iPad (used for the surveys and to display the course to participants), a voice recorder, and the necessary cables needed to upload the data. Furthermore, an OV Fiets, a bike rental service common across the Netherlands was used through these trials as it was among the simplest and cheapest options available in the area. Thus every participant rode the same type of bike, the Dutch bike, made of steel, and where participants ride upright. (Bruntlett and Bruntlett, 2018).

### 2.5.1 Emotibit Sensor

The Emotibit is a wearable open-source biometric sensor module, designed by engineers and designers at Connect Future Labs (Emotibit, 2023). It has over 16 signals, one can stream from. An Electrodermal Activity (EDA) sensor measures emotional status, intensity, cognitive status, physiological activation. A photoplethysmogram (PPG) measures heart rate (HR), heart rate variability (HRV), respiration, oxygen saturation and more. There are also humidity and temperature sensors, a 3-Axis magnetometer for cardinal direction, and a 6-Axis Accelerometer and gyroscope to measure gesture and rotation activity.

The Emotibit has a downloadable cross-platform visualizer that looks like this:



Figure 3. Emotibit cross-platform visualizer. Screenshot from Emotibit.com (2023)

It is through this visualizer that the researcher can prepare the device for a trial by: checking the battery levels and ensuring there are no clipping events (detectable errors, as in data figures clearly outside of a reasonable range for any given sensor). If that is all in order, then the researcher can begin recording the data from here. In our case we would also set the device to low-power mode to save battery, before embarking on a trial. The only difference between this and the conventional power-mode was that the data would not live-stream to this visualizer, which was not necessary for our purposes, especially considering that it drained the battery considerably faster.

Ultimately it was decided to go with this device over others for a few reasons. First the cost of this device was considerably cheaper than many similar sensors we looked at. Even with some of the add-ons we made both from the Emotibit website (like the Emotibit Essentials Kit, complete with Adafruit Feather, 400mAh battery, MicroSD card and reader, etc.) and external sources (wet gel electrodes), our total cost still came out to around a 5<sup>th</sup> of the price of the next cheapest device we considered (Emotibit, 2023; Emaptica 2023; Movisens, 2023).

Furthermore, the sampling rate for the data seemed overall good. In the case of the EDA data, that was of particular interest to us the, the Emotibit even performed better than one of the competitor brands we seriously considered, Emaptica. As can be seen in the chart below, the Emotibit has a sampling rate of 15hz for the EDA data, whereas for the EmbracePlus it was only 4hz (Emaptica, 2023).

Table 2. Sampling rate and data type for Emotibit sensor. Source: Emotibit.com (2023)

Function	Data Type	Sensor IC	Sampling Rate (samples per second)
Motion	AX AY AZ GX GY GZ MX MY MZ	BMI160+BMI150	25
PPG	PI PG PR	MAX30101	25
Temperature	T0 / TH	MAX30101 / MLX90632	7.5
EDA	EA EL ER	ADS1113	15

### 2.5.2 EDA Data Brief Overview

Electrodermal activity (EDA), is the preferred umbrella term used to define changes in electoral skin conductance (Posada-Quintero et al., 2018 ; Critchley 2002). This includes both slow shifts in basal skin conductance level (SCL) and more rapid transient events, that is, skin conductance responses (SCRs), which have also been referred to as galvanic skin responses (GSR) (Venables and Christie 1980; Boucsein 1992; Dawson et. Al. 2000).

EDA is considered a reliable psychophysiological measure of sympathetic nervous system activity, and hence it is thought to reflect changes in arousal levels that are influenced by emotions and thoughts (Critchley 2002; Critchley, 2010; Boucsein, 2012).

EDA is typically measured in microsiemens ( $\mu\text{S}$ ), also referred to as micromhos ( $\mu\text{mho}$ ). (Braithwaite et al., 2013). For the purpose of this thesis the microsiemens ( $\mu\text{S}$ ) naming convention shall be used.

Table 3. Electrodermal components basic definitions (adapted from Dawson et al, 2001).

Measure	Definition
Skin conductance level (SCL)	Tonic level of electrical conductivity of skin
Skin conductance response (SCR)	Phasic change in electrical conductivity of skin
Non-specific SCR (NS-SCRs)	SCRs that occur in the absence of an identifiable eliciting stimuli
Frequency of NS-SCRs	Rate of NS-SCRs that occur in the absence of identifiable stimuli
Event-related SCR (ER-SCR)	SCRs that can be attributed to a specific eliciting stimulus

There are two main components to the EDA complex. One component consists of the tonic-level EDA relating to the slower acting components and background characteristics of the signal (the overall level, slow climbing, slow declinations over time). SCL is the most common measure of this component with changes in the SCL thought to reflect general changes in autonomic arousal. The phasic component, or SCR, is the other referring to the faster changing elements of the signal. Evidence suggests both components are important and that they may rely on different neural mechanisms (Braithwaite et al., 2013; Dawson et al., 2001; Nagai et al., 2004).

It should be noted that the background tonic EDA (SCL), tends to be changing constantly within and individual, and can vary substantially between individuals. Some researchers have thus concluded that the SCL level on its own is not that informative of a measure (Braithwaite et al., 2013; Boucsein, 2012). This can be clearly seen in the EDA data that was gathered in these trials, with participants' baselines varying widely. Because of this, the analysis in the thesis will instead focus on observable changes in the EDA readings. See the results section more.

### 2.5.2.1 Methodological Issues with Quantifying Phasic ER-SCRs

In any experiment seeking to measure EDA, one must determine whether a given SCR is event-related or non-specific. Criteria that is too loose, risks including NS-SCRs into the analysis for ER-SCRs and thus mistaking these values to be tied to experimental manipulation. Criteria that is too strict risks missing many ER-SCRs that meet the criteria thereby wrongly discarding or misclassifying them as NS-SCRs (Braithwaite et al., 2013; Dawson et al., 2001) A graphical representation of these components is provided below.

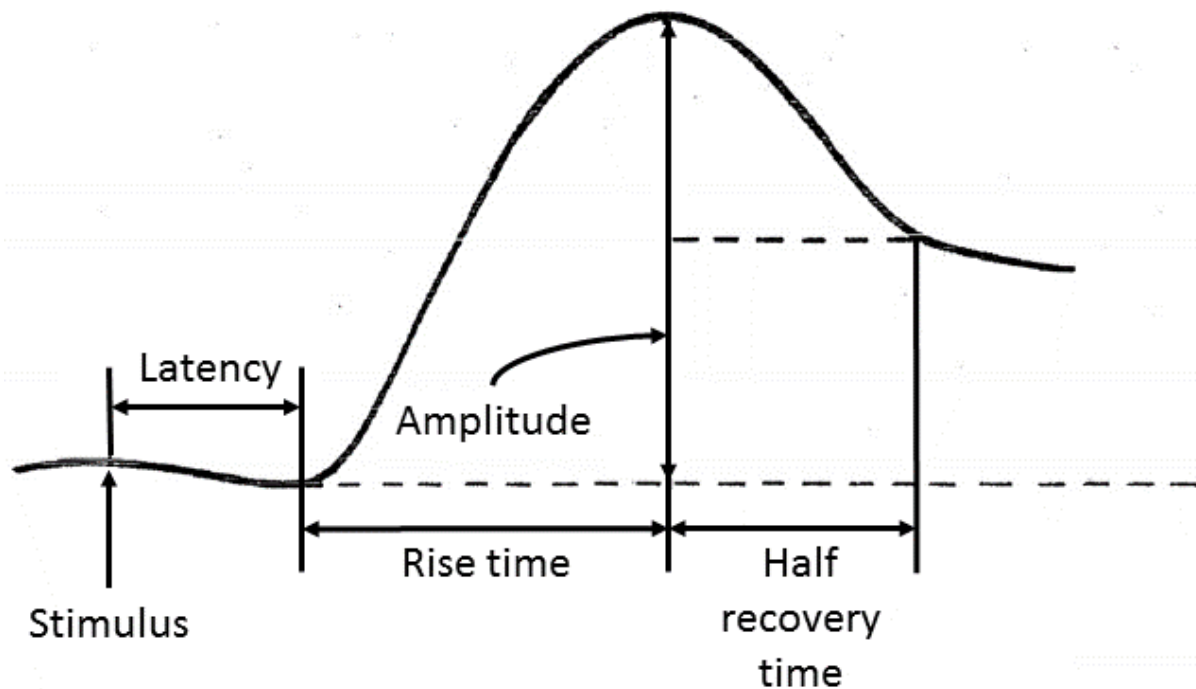


Figure 4. Time-domain measures of EDA based on the specific SCR caused by an instantaneous stimulus (taken from Posada-Quintero, 2016) This chart attempts to describe how a certain degree of latency, around 1-3 seconds is needed for data spike to be considered sufficiently correlated to a stimulus event. Otherwise the data spike cannot be considered sufficiently correlated to the stimulus event.

#### 2.5.2.1.1 Latency

An ER-SCR is typically defined as an SCR whose latency period between the stimulus onset and the first significant deviation in the signal is between 1-3secs. If signal deflections occur before this period, then typically defined as NS-SCRs and thus not viewed as coming directly from experimental manipulations (Braithwaite et al., 2013; Posada-Quintero, 2016).

In the case of these trials, there is not per se specific experimental manipulations to the EDA data. Since the trials take place outside, on a bicycle ride many potential external stimuli may have impacted the results. What was looked for here, was the impact of specific stress stimuli that participants mentioned, to see what impact it had on their EDA data. This was used to triangulate and compare it to how the data looked when they mentioned particular moments that they may have been in the flow state or other noteworthy positive emotional experiences, to see if any consistencies can be found in the EDA trend lines between them.

### *2.5.2.2 EDA and our python script*

To better visualise the EDA in a graph over time, my colleagues responsible for the python code used to input data ensured that the code would take the average of the respective 15hz sample. That way instead of having to interpret 15 different variables on the same second of the time stamp, we would only have to look at one. This technique trades some level of accuracy for a greater ease in interpreting the results.

### *2.5.3 EDA in previous urban and cycling research*

Previous research has used Electrodermal activity (EDA) devices to help researchers get a sense of individuals' emotional response within urban and other environments (Fathullah and Willis, 2018). Many of these also examine the cycling experience as well, through various measures such as Electrodermal activity (EDA), heart rate, heart rate variability, and many more (Werner, Resch and Loidl, 2019; Nazemi and van Eggermond, 2020). However, these research papers tend to focus their efforts on the measurement of negative motions such as stress. This is with good reason too, as emotions like stress appear to garner a more consistent reliability profile when it comes to the ability of such devices to consistently measure them in various individuals (Horvers et al., 2021). A deeper dive into the papers below attempts to examine this further, and demonstrate how, the methods of this research endeavour attempt enhance the accuracy of positive emotional sensing through a blending of both quantitative (sensor, camera) and qualitative (surveys, interview, etc.) data.

#### *2.5.3.1 Previous use-case in cycling research*

There have been at least a few other studies utilizing EDA as a means to quantify cycling stress levels. In one from the university ETH Zurich, up to 150 participants rode through 5 different cycling environments in an immerse 360-degree virtual reality (VR) environment while their elicited SCRs were collected by an EDA sensor throughout the duration of the experiment. Significant differences in SCRs between different cycling environments were not detected when the signal was analysis for the entire stretch of the respective cycling courses. However, when smaller segments were compared, significant differences were revealed. Cycling on a shared sidewalk with pedestrians caused higher stress levels. Cycling on segregated bicycle paths were found to be the least stressful. Furthermore, evidence was found that linked SCR rates with self-reported perceptions of safety (Nazemi and van Eggermond, 2020).

In another study conducted in Salzburg, Austria, EDA, skin temperature, and GPS data was collected from of 21 participants (of which only 17 contributed valid data due to technical issues). Each conducted 4 cycling trips across 4 different routes, with a different mixture of bicycle infrastructure and road categories. A total of 100 valid trips were processed. The aggregation of this sensor data along with data collected through a survey, helped to create moments of stress (MOS) datasets that included measured and reported stress per individual trip, stress range per participant, stress per route (and direction), and stress per route and participant. This culminated into an average MOS per km for all trips. The results indicated that while high divergence exists partly between measured and reported stress on the individual trip level, aggregated measured and reported stress per route showed clear correlations across participants. Non-random spatial distribution of MOS revealed a common sensation of stress hot spots within the road network among participants. This was pair with survey data results indicating safety and scenery as having highest influence on positive route perception, whereas safety concerns formed the strongest cause for dislike of a route, followed by the lack of route-simplicity making it difficult to find (Werner, Resch and Loidl, 2019).

#### 2.5.4 Insta360 camera

The Insta360 ONE RS camera was used for these trials, as Mobycon already owned this piece of equipment. We had at our disposal two different lens options. A 360° lens that whose video files come in an *insv* format, and a 4K wide angle lens, whose files come in the more typical, *mp4* file type (Insta360, 2023).

The 360° lens was used to get a recording of the cycling route. With this lens type visual data on the entirety of the course could be made able for later evaluation and analysis. Still images from this shall be presented in sections below.

The 4k lens was chosen for the participant cycle trials, as it proved easier to work with the *mp4* file type actively during the trials, rather than the *insv* file type of the 360° lens. In the trials, the camera was used primarily to capture recordings of participants' facial expressions and as tool for recall in the post-ride interactive interviews. As with the other types of identifiable data, participants' reserve the right to revoke the use of this data, and thereby it would not be included in the results.

The decision was made to employ such a method, based on the recommendation of Expert 2 who described such a technique where they observed facial expressions of cyclists, interpreting said expressions as either being stressed, bored, or in flow. Reference was made to Christopher Alexander's concept of pattern languages (1977), as that perhaps facial expressions may serve as a kind of pattern language, that give insight into an individual's mood, and hence a better understanding of how individuals are reacting to or interpreting their environment may be revealed. Yet while one may be able to describe what is happening there, it is difficult to put into tangible variables that can clearly be measured (Samuel Nelodeke & Te Brommestrat, date). The article *You get great insights on the bike. This is how you get into the cycling flow* by Thalia Verkade (2021) was also mentioned as it contains within an unconnected project by Belgian artist Max Pinckers, called *Transitions (2014)*, that depicts the faces of people cycling. To the Interviewee, it was immediately clear that these facial expressions capture cyclists in a state of flow.

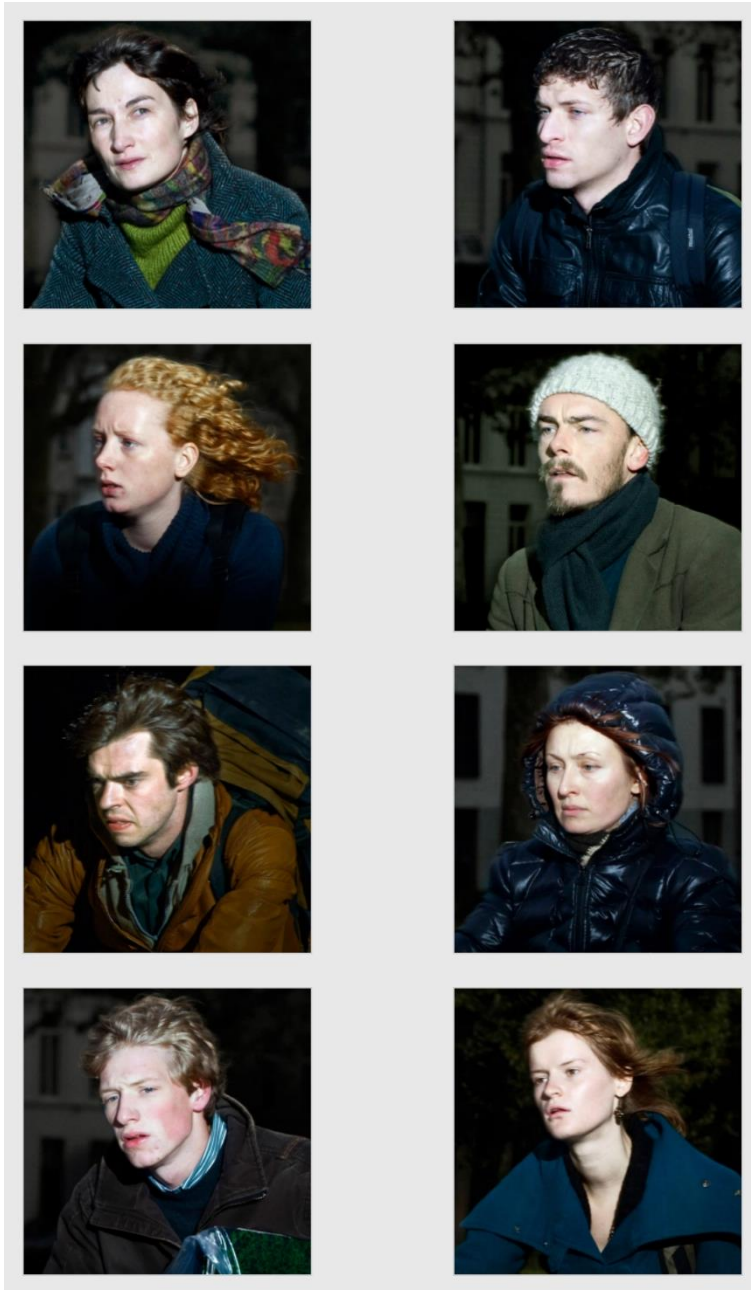


Figure 5. The facial of a cyclist in 'Flow' as interpreted by some experts. Photo Credit: Max Pincker's 'Transitions' (2014)

In all these pictures, these cyclists appear to be a deep focus, as their eyes stare intently in a particular direction. In all but one of these pictures, cyclists appear to have their mouths slightly open. Their eyes appear to demonstrate a sense focus and/or concentration, not necessarily at the path in front of them, but on something either internally or externally. By contrast, their mouth's being mostly open give a sense of relaxation, as these facial muscles themselves are in a relaxed position. So perhaps there is something here worth taking note of, that the face of a cyclist in flow provide both signs focus, intensity, or rather some sort of stimulus, while also presenting as seemingly relaxed at the same time; a facial expression with elements of stress and boredom, that demonstrates some sort of in-between state.

## 2.6 Limitations

A major limitation to keep in mind here is the limitation of myself the research. My experience and knowledge regarding quantitative data analysis has thus far been very limited. It has around half a decade, if not more since, I have taken any sort of formal mathematics course. So compared to other researchers with a lot more experience in this category my analysis may be lacklustre, especially when it comes to ability to quantify or estimate a given dataset's level of accuracy. So instead of attempting to a questionable job trying to calculate those numbers, I have instead simply opted to highlight potential trends and correlations noticeable between the sensor data presented with that of similarly time stimuli, captured either through trial video footage or mentioned in the recorded interactive interviews. My hope is that if I presented these trends and correlations in a sufficient manner, future researchers with better quantitative data analysis skills, will better be able to quantify the data accuracy levels of these trials, or similar future trials.

This project is the first time I have ever worked with python, so hence there was a lot of limitations to my knowledge of the program. Thankfully fellow Mobycon colleagues were primarily responsible for this portion, and were able to help when I encountered some challenges in the code during a few trials. For the most part, I just had to know what the necessary command were prompts to enter, and how they related to and interacted with the Emotibit software.

The Emotibit sensor itself presented some limitations, in that I at times it would prove difficult to work with, giving insufficient or error filled data, until my colleagues and I adjusted the method. Even then there were a few trials where the device simply stopped recording, before participants were even on the bicycle.



## 3 Theoretical Framework

In this chapter, I discuss various pieces of academic literature, that have been examined to better understand what has been covered by existing works and what research gaps still exist. This chapter is intended to exemplify the main theoretical concepts and their relationships to one another.

This chapter begins with a background on the concept of 'flow', what it is, how it is characterized, how is it commonly used or thought of today. Various works of Mihaly Csikszentmihalyi, the man who first postulated the concept, as well as that of other authors who have built on his research are examined, to better understand and summarise the concept of 'flow': its origins, historic use cases, and the potential promise it may hold for the transportation sector. Works like Marco te Brömmelstroet and colleagues' (2021), *Have a good trip! Expanding our concepts of the quality of every travelling with Flow Theory*, is one of the first papers to establish this link between psychological flow and the transport sector.

This theoretical framework strives to build on this work by linking flow theory to the urban planning theories of placemaking and urban vitality. These concepts shall also be summarized below and examined regarding their relevance for route planning and design for recreational cycling.

Specific sub-concepts and tools like (nature-based placemaking and the CROW design principles) are examined to better understand their strengths and weaknesses regarding cycle-route design, and how flow theory might be able to fill the gaps present within placemaking and urban vitality, thereby increasing the robustness of these concepts.

### 3.1 Flow

What is flow? According to the Cambridge dictionary, the word flow has at least six different definitions, three when used as verb (referring to movement, continuation, and hanging down), and three when used as a noun (referring to movement and continuous numbers). In everyday spoken language, flow is used to refer to a variety of things such a cash flow, lava flow, flow charts, and a flowing river. These are all seemingly different concepts, yet united by the underlying implications of movement and continuation. As mentioned in the introduction, this thesis closely examines the concept of flow as has been conceived of in the psychological literature. Historical research surrounding flow was primarily spearheaded by the Hungarian American psychologist, Mihaly Csikszentmihalyi beginning in 1970.

Flow, as it is perceived within the field of psychology, is an experience that occurs when a person is fully immersed in doing something that provides enough challenge to keep the person concentrated, avoiding boredom or distraction. Even if mundane, this experience is profoundly enjoyable, and valuable in and of itself. Furthermore, it often has a transformative aspect lasting beyond the initial experience (Csikszentmihalyi 1977). According to Csikszentmihalyi, this experience of flow brings order to consciousness, making one's life more enjoyable and meaningful overall. This bestows a sense of control and connectedness as viewed from an outside perspective. Being that this sense of deep enjoyment is highly rewarding, it is very common to observe people expend a great amount of energy to get into this mental state. Surfers, dancers, musicians, and gamers are commonly associated with 'flow', yet the state can occur in a wide variety of contexts, including travel.

### 3.1.1 Csikszentmihalyi and Flow:

To best understand the psychological concept of “flow”, it is useful to have some background on the man who recognized and named the concept, Mihaly Robert Csikszentmihalyi. He was born on the 29<sup>th</sup> of September 1934, in Rijeka, Croatia, (Cooper, 1998) what was then known as Fiume, and part of the Kingdom of Italy (Risen, 2021). His father worked for the Hungarian Consulate there before being appointed the Hungarian ambassador to Italy shortly after World War II (Kawamura, 2014). He resigned from this position when the Communist party took over Hungary in 1949. The regime thus responded by expelling and stripping the Csikszentmihalyi family of Hungarian citizenship (Kawamura, 2014). Thus, the elder Csikszentmihalyi opened up a restaurant in room to earn a living, and Mihaly dropped out of school to help support the family (Cooper, 1998).

Csikszentmihalyi’s initial curiosity around happiness was sparked by the suffering he witnessed among Europeans during World War II. After many jobs, homes, and sense of security lost, it was clear from that many people were unable to find satisfaction in life. This prompted him to explore the question of what makes life worth living, and delving into art, philosophy, and religion to find answers (Steimer, 2021 & Oppland, 2016).

When traveling through Switzerland as a young man, Csikszentmihalyi stumbled into a lecture by Carl Jung. Jung spoke of UFO (Kawamura, 2014) sightings and how the traumatized psyches of Europeans after World War II, and the subsequent mental states that caused them to project them into the sky. This talk piqued Csikszentmihalyi’s interest in psychology (Steimer, 2021).

### 3.1.2 Origins of the Concept

Through the lens of psychology, Csikszentmihalyi developed a fascination for artists who became fully engrossed in their creative endeavour to the point of disregarding fundamental biological needs such as food, water, and sleep. Many of these interview subjects used the metaphor of water carrying them along to describe their experiences (Steimer, 2021). Others simply described their optimal performance states, as when work simply flowed out of them, with little effort needed (Oppland, 2016). It is from this, that term and positive psychological concept of the “flow state” was born (Steimer, 2021).

#### 3.1.2.1 The 8 traits of Flow

Csikszentmihalyi describes flow as “a state in which people are so involved in an activity that nothing else seems to matter; the experience is so enjoyable that people will continue to do it even at great cost, for the sheer sake of doing it” (1990).

To better define the state, Csikszentmihalyi describes eight characteristics of flow:

1. *Complete concentration on the task.*
2. *Clarity of goals and reward in mind and immediate feedback.*
3. *Transformation of time (speeding up/slowing down).*
4. *The experience is intrinsically rewarding.*
5. *Effortlessness and ease.*
6. *There is a balance between challenge and skills.*

7. *Actions and awareness are merged, losing self-conscious rumination.*
8. *There is a feeling of control over the task* (Oppland, 2016; Csikszentmihalyi 2002).

### 3.1.3 Research, Use cases and Evolution Beyond Csikszentmihalyi

As was mentioned in the methods section, people can differ in their ability to experience flow. Those with *autotelic* personalities, studies show, tend to experience more flow. (Heilala, 2022; Tse et al., 2018; Nakamura & Csikszentmihalyi 2002) Autotelic derives from two Greek words *auto* meaning self, and *telos* meaning goal (Csikszentmihalyi, 1990). The term refers to a self-contained activity done not for some other external goal or future expectation, but simply because the activity itself is its own reward.

The research on Flow theory has continued relating it to activities such as education (Schmidt, 2010) work, leisure activities like music performance, dance, writing, sports (Biasutti, 2017) and gaming (Reese, 2016).

As per our knowledge, comparatively little has been written connecting the concept to urban planning and design. But the inklings of this connection have begun to come together, with it being argued *“that the concept of flow has the potential to further expand the understanding of human scale planning and policy in transport practice”* (Te Brömmelstroet et. al, 2021). More will be elaborated on this point in Section 3.1.5. Another notion that has been explored is the connection of flow to place identity (Bonaiuto et al., 2016). While such a connection is still firmly entrenched within the field of psychology, a stepping-stone is presented for how flow might be connected to more traditional urban planning concepts like placemaking.

### 3.1.4 Traffic Flow vs Psychological Flow

Among urban planning circles, particularly those who deal with and hold an expertise in traffic planning, the term “flow” has an entirely different meaning than how it is used in psychological literature. Flow to the conventional traffic planner holds no reference to an individual’s psychology, but rather to the “flow” or continuous movement of traffic (Lieu, 1999).

Just like psychological flow, the flow-of-traffic is often viewed as an optimal state. Many traffic planners and engineers could even attest the bulk of their careers to striving towards that goal: one of minimal traffic congestion, and a continual, flow, or movement of cars, bikes, pedestrians, etc (Marohn, 2021). It is therefore crucial to make this distinction, especially in an urban planning thesis, as confusion or conflation of these two distinct concepts could easily be made.

One may postulate however, that the two may share some relation, as one could imagine perhaps that it is easier to remain “in-the-zone” and present while cycling if one does not have to stop constantly. But as shown by the empirical findings in this thesis, that could depend on the individual, or the demographic group being studied.

### 3.1.5 Flow and Cycling

In the paper, *Have a good trip! expanding our concepts of the quality of everyday travelling with flow theory*, (Te Brömmelstroet et. al, 2021), the authors attempt to challenge the dominant notion in transport planning and policy in which travel, and travel time are seen as an economic disutility. Rather, they take the stance of a growing body of literature, that being ‘on the move’ can have positive implications on an individual's quality of life, well-being, and personal development. At the same time, they also recognize that it is frequently reported that commuting particularly or travel in general are amongst the least pleasant daily experiences. With that in mind, the authors proposed that Csikszentmihalyi’s flow theory has the potential to offer important valuable insights that can help drive policy action and further research towards daily mobility forms such as cycling that are both sustainable and *satisfying*.

Te Brömmelstroet et. al. focus on the idea of “intrinsic value’ of travel (Mokhtarian & Salomon 2001), that challenges the rationale of microeconomic consumer theory (Urbina and Ruiz-Villaverde, 2019), criticizing this traditional monetization of travel time savings, that assumes that infrastructure and service provision are the most important aspects of high-quality mobility (Banister et al. 2013; Jones, 2009). Thus, the value contained within more individualised accounts of mobility are often overlooked (Schiefelbusch, 2010).

The paper overviews the ‘mobilities turn’ in social sciences which argues that being on the move is a fundamental condition of human nature (Cresswell 2006, 2011, 2014; Elliott and Urry 2010; Mladenović et al. 2019; Van Geenhuizen and Nijkamp, 2003). Everyday mobility is not exceptional, but rather intrinsic to life, society, and space (Grieco and Urry, 2012) playing a crucial role defining, sustaining, and/or transforming subjective experiences (Doody, 2020). Thereby, a huge aspect of travel often overlooked, is the identity, social meaning, and embodied experiences it creates (Ferreira, 2019). Daily mobility can thus play crucial roles as personal development tools and to convey meaning to places (Simmel, 1971; McLuhan, 1995; Ferreira et al. 2012).

The figure below is based on the core affects theory. Core affects are defined as the building blocks of the individual’s current mood or emotional response (Västfjäll et al. 2002). The theory is based on the idea that it is not possible to feel the two opposite sides of the so-called circumplex simultaneously. The theory contains two primary dimensions: valence and activation. Valence is the extent of experienced pleasure (ranging from positive to negative), whereas activation is arousal or feeling energized by environmental stimuli (ranging from activated to deactivated) (Västfjäll et al. 2002; De Vos et al. 2015).

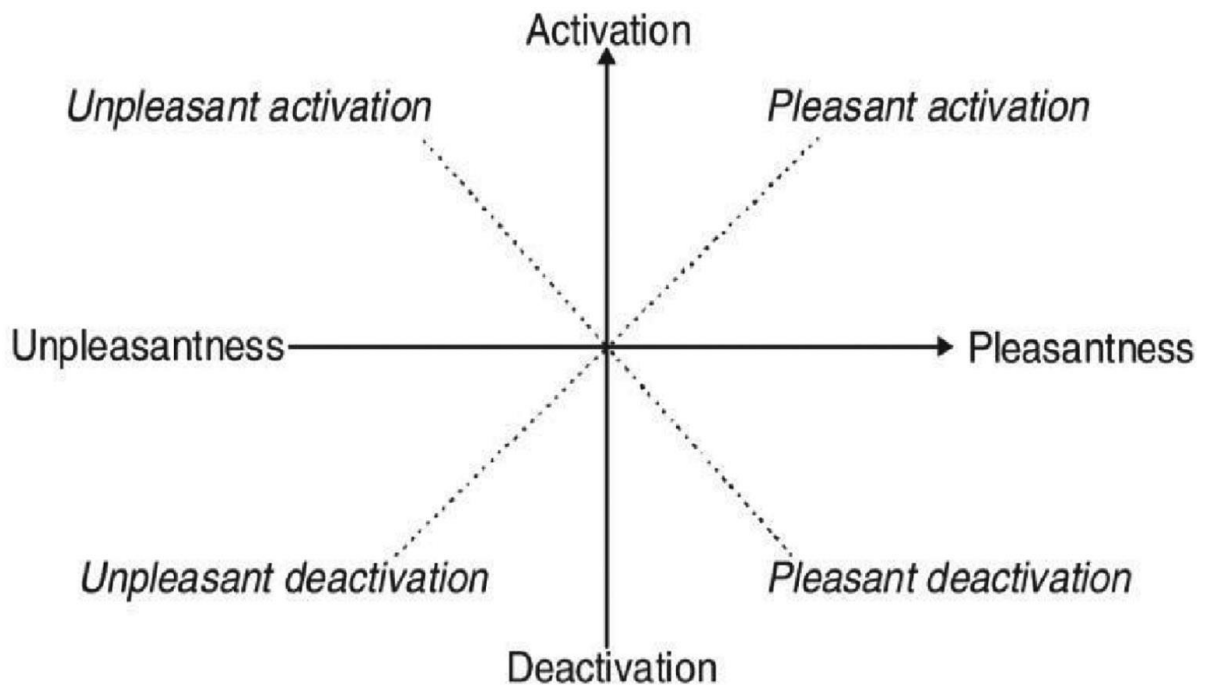


Figure 6. The circumplex model of core affects (Västfjäll et al., 2002).

The Satisfaction with Travel Scale, a foundational model of travel satisfaction methodology, (Ettema et al. 2011), that measures travel perceptions in terms of evaluative happiness and emotional well-being (Ettema et al. 2011; Diener 1984) is based on the core affects theory (Russell 1980; Västfjäll et al. 2002). As Friman et al. (2013) argued, when measuring travel satisfaction, both valence and activation should be measured at the same time. As seen below in Figure 5, Csikszentmihalyi's flow model (1997, p. 31) may be interpreted as having a good encapsulation of these principles. Skill level is used in place of valence. Challenge level is used in place of activation. Hence a state of flow, from a travel satisfaction perspective, could be said to align with a sense of pleasant activation (as seen in Figure 4).

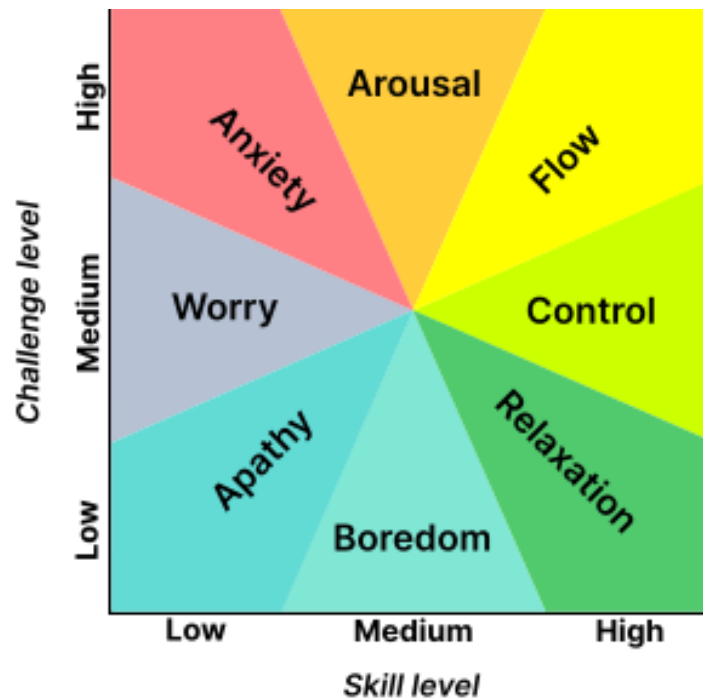


Figure 7. Mental states in terms of challenge and skill level. Source: Csikszentmihalyi (1997, p. 31).

One of the main points of the *Have a good trip!* paper, supported by the above literature, is that travel time should not be reduced to units simply of time and money, as it is infused with profound, multi-layered, and sometimes contradictory meanings. Travel experiences should therefore be seen as a multidimensional reality that will require the input of variety of theories and methods from various disciplines in order to develop a proper understanding (Te Brömmelstroet et. al, 2021). This is where Flow Theory can come into play, as it may help to provide an explanatory framework for the mechanisms and manifestations through which travelling becomes a pleasant experience in the first place, since it considers several of the elements of travel experience like, sensorial, motor, cognitive and emotional processes.

In the case of the study presented within the *Have a good trip!* paper, an exploratory online questionnaire was conducted where participants were asked about their most frequently used transport mode and the eight possible mental states defined by Csikszentmihalyi (1997, p. 31) they might experience during travel and the environmental and personal conditions that may trigger such states. The mental states used were apathy, worry, anxiety, arousal, flow, control, relaxation, and boredom as shown in Figures 5 and 6. They also provided descriptions of personal strategies they used to actively alter their mental states towards more desirable ones or to avoid undesirable ones. They further provided information regarding the frequency which they experienced manifestations associated with the state of flow like concentration, merging action and awareness, disregard from the sense of self, perception of time, sense of reward and creativity, as well as some general sociodemographic information like gender, age, nationality, educational level, level of urbanity, and transport mode preferences.

The results were exploratory in nature, using a small sample size of 91 respondents deriving from the distribution of the questionnaire on social media platforms and targeted emails to international academic networks, hence it may be a relatively biased group of participants, the results are nonetheless intriguing.

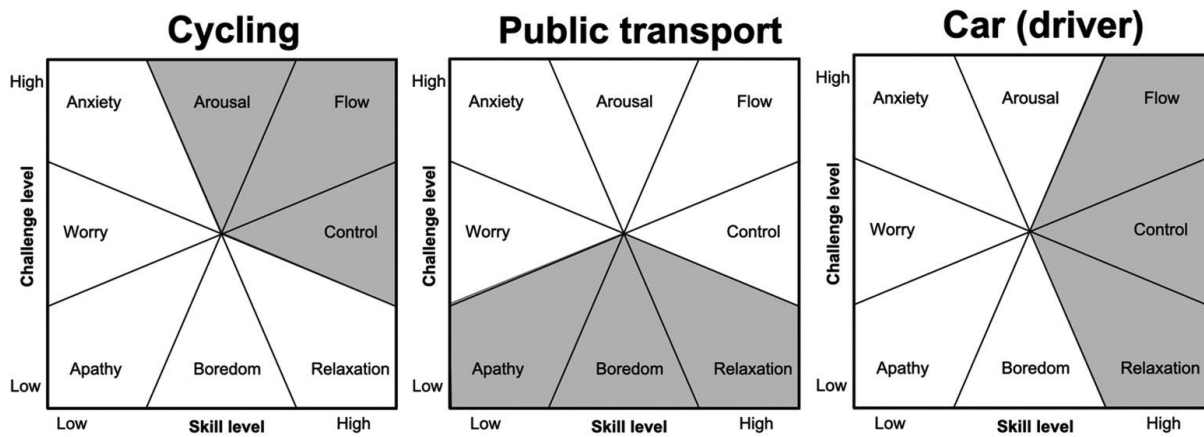


Figure 8. Which of these mental states do you experience frequently while traveling with your primary mode? Source: *Te Brömmelstroet et. al, 2021, inspired from original designs by Csikzentmihalyi, 1997 p. 31.*

The main recognized states by respondents were flow (61%), control (51%), relaxation (50%) and arousal (44%). Most relevant to this master’s thesis, was that cyclists primarily recognized mental states associated with high skill and challenge levels (flow, 85%; arousal, 67%; control, 67%).

Table 4. Environmental and personal conditions to trigger a flow state for cyclists. Source: *Derived from Te Brömmelstroet et al., 2021.*

Mode	Environmental conditions for Flow	Personal conditions for Flow
Cycling	Weather conditions: wind for some, lack of wind and sun for others	Not being tired
	Urban design: beautiful landscape, clever/safe urban design, green spaces/trees	Good mood, looking forward to rest of day
	Infrastructure: No traffic lights, several say quiet routes, some say lively streets. Easy to understand.	Being undisturbed
	Others: low number of other cyclists. Negotiating with people who cross my path.	From work to home instead of vice versa
		Not being late
		Fitness level

The study also examined the environmental and personal conditions that contributed to flow, as was listed by participants. These are listed above in Table 4. Furthermore, the study examined the strategies employed by participants to trigger or avoid certain mental states. These are listed below in Table 5.

Table 5 Stated personal strategies to trigger or avoid particular mental states. Source: Derived from Te Brömmelstroet et al., 2021.

Mode	Strategies for desirable mental states	Strategies to avoid undesirable mental states
Cycling	Take routes that are safe, aesthetic, avoid traffic lights.	Avoid long stretches without turns
	Toggle music	Slow down/speed up
	Take a longer route on separated infrastructure	Avoid noisy routes/pedestrian areas.
	Take residential streets	Take the lane, establish eye contact
	Variation (of route/riding style)	Take extra time
	Meditate on emotions/breathing/body	
	Pass travelers, cycling through red light, seek busy times for travelling	

One of the main takeaways from this publication was that travel modes involving physical movement, a deep involvement of the body, and thus a high control over the trip, such as cycling, offered more opportunities for experiencing flow (source). Such results may help to further our understanding of design requirements. This contrasts with the current focus of reducing stress levels in cycling environments (Fitch, Sharpnack, and Handy, 2020) may provide more ‘flow’ opportunities in presently high anxiety contexts but may eventually lead to boredom if take too far or applied inappropriate contexts.

Having explicated the concept of flow, the author gives an overview of the second main concept addressed in this thesis; placemaking.

### 3.2 An Overview of Placemaking

According to the paper ‘Definition of Placemaking: Four Different Types’ by Mark A. Wyckoff, (2014), placemaking is a *process*, a means to an end; with that ending being the creation of *Quality Places*. Wyckoff defines placemaking as, “*the process of creating quality places that people want to live, work, play and learn in.*” (Wyckoff, 2014, p. 2).

According to the organization ‘Project for Public Spaces’ (PPS) (2019), “*placemaking inspires people to collectively reimagine and reinvent public spaces as the heart of every community.*” Inspired by the 1960s thinkers Jane Jacobs and William H. Whyte, who gained traction for ideas like designing cities for people, instead of cars and shopping centres, PPS began to cultivate a placemaking approach. The term “placemaking” however was not consistently used until the mid-1990s to describe this approach. To PPS, placemaking is considered both a process and a philosophy. A huge focus is placed on participation, observing, listening to, and asking questions to the people who live, work, and play in a particular space to understand their needs and aspirations for that space and for their community as a whole (Project for Public Spaces, 2019).



To understand what makes a quality place, one must understand the difference from a standard place. A parking lot is a *place*, so too is a house, residential subdivision, or main street. The primary concern here is with places that people care about and want to be in, as these are places that have a strong *sense of place*. (Wykoff, 2014, p. 2). Hence, places that contain this strong sense of place are referred to as Quality Places. These are places where both businesses and people want to be. They are locations that contain interesting, active and unique attributes, are visually attractive, typically holding creative activities and public art. Such places tend to be safe, walkable people-friendly environments with mixed uses. The dimensions of the buildings are well-thought-out relative to the street [The ideal ratio being between 1:3 and 1:2 (Singh, 2016)], and so too are the look of the façades, creating a sense of allure to the space. Figure xx below shows demonstrates the Place Diagram which is a tool developed to help communities evaluate places. The inner ring represents key attributes of place, like its sense of comfort, sociability, and accessibility. The middle ring represents intangible qualities like pride, *vitality*, cleanliness, or continuity. The outer ring represents measurable data of these key attributes like volunteerism, land use patterns, sanitation rating, and modal splits.

## What Makes a Great Place?

Project  
for Public  
Spaces

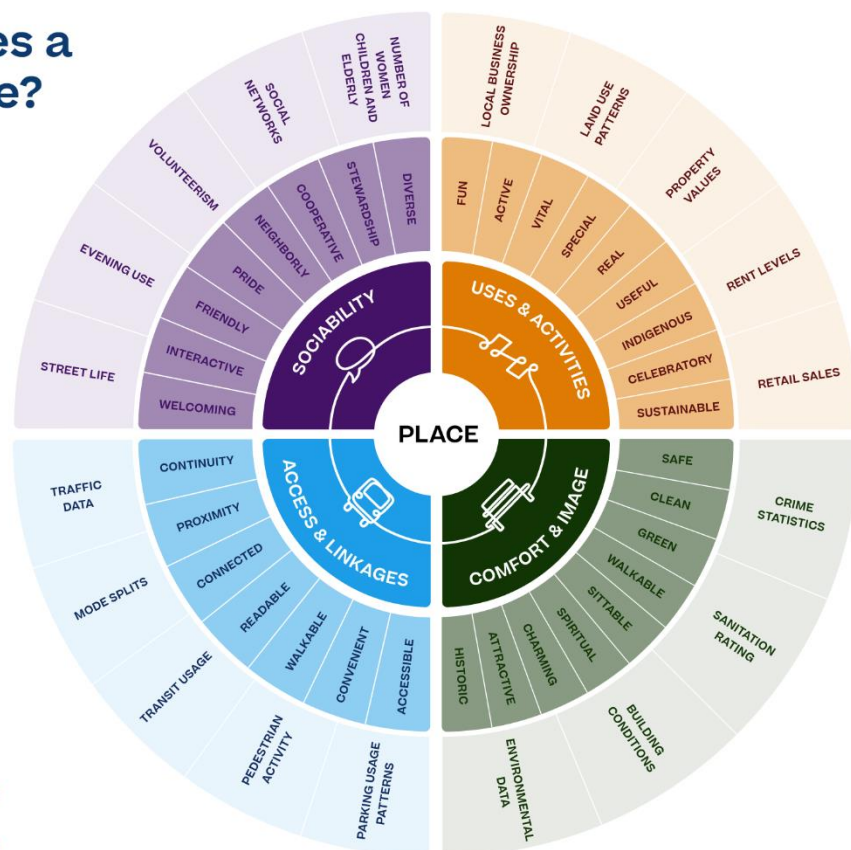


Figure 9. The Place Diagram is one of the tools developed to help communities evaluate places. The inner ring represents a place's key attributes, the middle ring its intangible qualities, and the outer ring its measurable data. Source: Project for Public Spaces, 2019.

Organizations like the PPS have gone on to develop several tools and principles to help citizens bring about changes to their communities. The place diagram above, is one such tool. The key idea from PPS and several other organizations that work with the concept, is that **placemaking belongs to everyone**. For this be the case, placemaking must be community-driven, visionary, consider function before form, adaptable, inclusive, focused on creating destinations, context-specific, dynamic, trans-disciplinary, transformative, flexible, collaborative, and sociable (Project for Public Spaces, 2019). This sets the

foundation for elements of Quality Places like mixed-uses, quality public spaces, broadband enabled, multiple transportation options, multiple housing options, preservation of historic structures, community heritage, arts, culture, and creativity recreation, and green spaces (Wyckoff, 2014, p. 2), as those who make use of these newfound places feel as if they have stake in them. Section 3.2.1 below describes the four types of placemaking as elaborated by Wyckoff (2014).

### 3.2.1 Four Types of Placemaking

This section was primarily derived from Mark A. Wyckoff’s paper DEFINITION OF PLACEMAKING: Four Different Types (2014) and will break down the relationship between these types of placemaking as visualized in Figure 8 below. Special attention is given to the relationships between physical form, land uses, functions, and social opportunity in creating Quality Places.

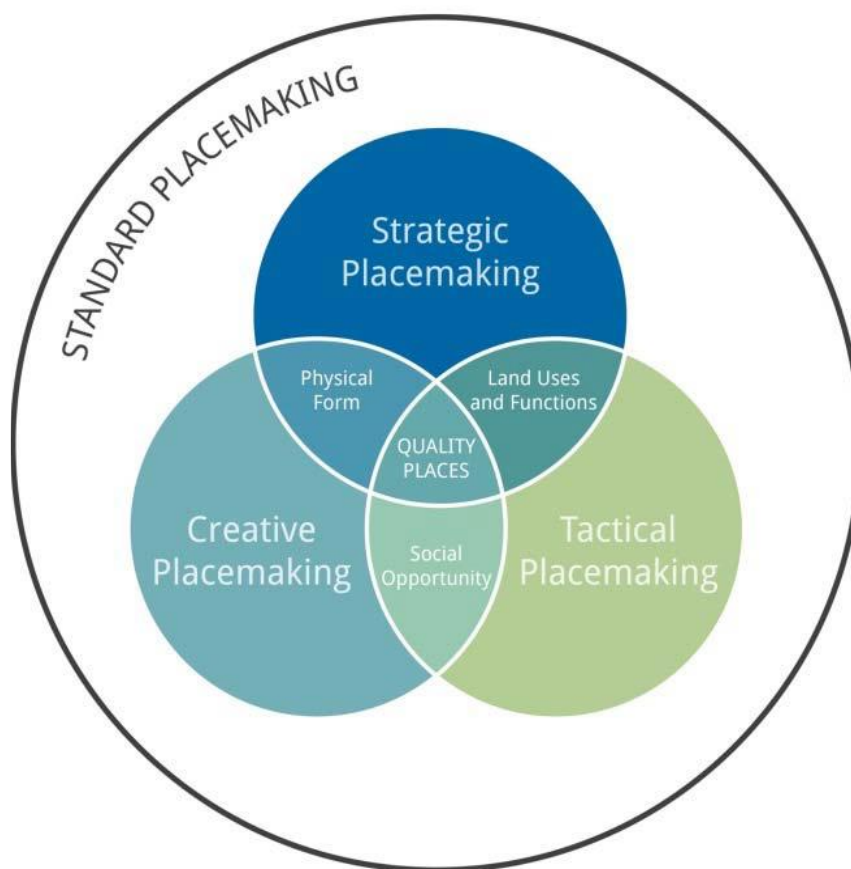


Figure 10. Four Types of Placemaking and their respective relations to one another. Source: Wyckoff, 2014.

**Standard Placemaking** (or just plain “Placemaking”), is most closely associated with and advanced by PPS (2019). It is the process of creating Quality Places that people want to live, work, play and learn in. It is typically pursued on an incremental or targeted basis, over a long period of time, if not continuously, by the public, private and non-profit sectors. **Projects** may include downtown street and façade improvements, small scale multi-use projects, neighbourhood-based projects residential infill, park improvements, etc. While **activities** could include events in public places such civic buildings, town squares, sidewalks, streets, etc. (Wyckoff, 2014; Steuteville, 2014).

**Strategic Placemaking** has been advocated by Michigan’s MIplace Partnership initiative (MIplaces and CNU, 2020 p. 24). It is a targeted process involving project/activities in certain locations (defined

corridors centres, and nodes). The goal here is to results in safe, human-scale, pedestrian-oriented, **bicycle-friendly**, quality, sustainable, mixed-use, green places, containing multiple housing and transportation options, respect for historic buildings, public spaces, arts and culture, recreation, and broad civic engagement. **Projects** may include mixed-use developments along key *corridors* (esp. rapid transit lines), *centres* (downtowns), and at key *nodes*. This may include both new construction and rehabilitation efforts. **Activities** are meant to add vitality to Quality Places, attracting a wider range of users through frequent, often cyclical events of arts, culture, entertainment, and recreational activities that often target talented workers. (Wyckoff, 2014; Steuteville, 2014).

**Creative Placemaking** is where the goal is often to institutionalize arts, culture, and creative thinking in all aspects of the built environment. Partners from the public, private, non-profit, and community sectors strategically shape the physical and social character of neighbourhoods, towns, cities, or a region to achieve this goal (Wyckoff 2014; Markusen and Gadwa 2010; Crisman 2021; Madsen, 2018). **Projects** will develop around and include arts, cultural and creative thinking. Museums and orchestra halls, live-work structures for creative people, public art displays like transit stations with art themes, etc., all fit into this category. **Activities** include new cultural, arts, and entertainment activities that add vitality to Quality Places such as outdoor concerts, movies in the park, chalk art projects, inclusion of children’s ideas in planning projects by means of artwork, etc. (Wyckoff, 2014; Steuteville, 2014).

**Tactical Placemaking** is the process of creating Quality Places using deliberate, often phased approaches that initiate with realistic expectations and short-term commitments that allow for a quick start, often at low cost. Two related approaches were brought together to create this, first tactical urbanism (Lydon, Garcia and Duany, 2015) and a set of principles from Project for Public Spaces called “*Lighter, Quicker, Cheaper*” (Project for Public Spaces, 2021) Public spaces can thus be targeted with low risk, and potentially high rewards. In areas with a mix of stakeholders, small projects, and short-term activities, it can be continuously used. Thereby, positive impacts may be slow to observe, but over a long time period, and often at a lower cost, Tactical Placemaking projects can transform an area. Examples of **Projects** include those that are small and short-term, transforming underused public spaces by leveraging local partnerships in an iterative approach allowing opportunities to experiment and demonstrate possibilities. This can include road diets (***shrinking a four-lane road to a three-lane with bicycle paths on both sides***) and other Complete Streets projects, pilot construction of a new form of dwelling in a neighbourhood, such as a passive solar home, etc. Associated **activities** include temporary activity spaces, parking space conversions, before and after photo renderings to illustrate the potential of removing or adding buildings in certain places, public gatherings over new design options encapsulated by new bike paths, park enlargements, or temporary facades, outdoor music events in town squares, self-guided historic walks, etc. (Wyckoff, 2014; Steuteville, 2014).

Section 3.2.2. below highlights the relevance of the concept of placemaking to cycling.

### 3.2.2 Placemaking and Cycling

A great example of cycling being utilised as an instrumental tool in the placemaking process, utilising the above definition of creating a quality place that people want to live, work, play and learn in, can be seen in the story of the northern Dutch city of Groningen. Being a town of modest size, it has often slipped under the radar in the discussions of the world’s cycling cities, despite having a modal share far above that of Amsterdam and Copenhagen (Bruntlett and Bruntlett, 2018). With a modal share claimed as high as 60% it is arguably, the world’s pre-eminent cycling city (competing with the likes of this project’s context area, Zwolle) (Baxter, 2020; Kim 2014). Figure 9 below shows the traffic circulation plan of the city of Groningen.

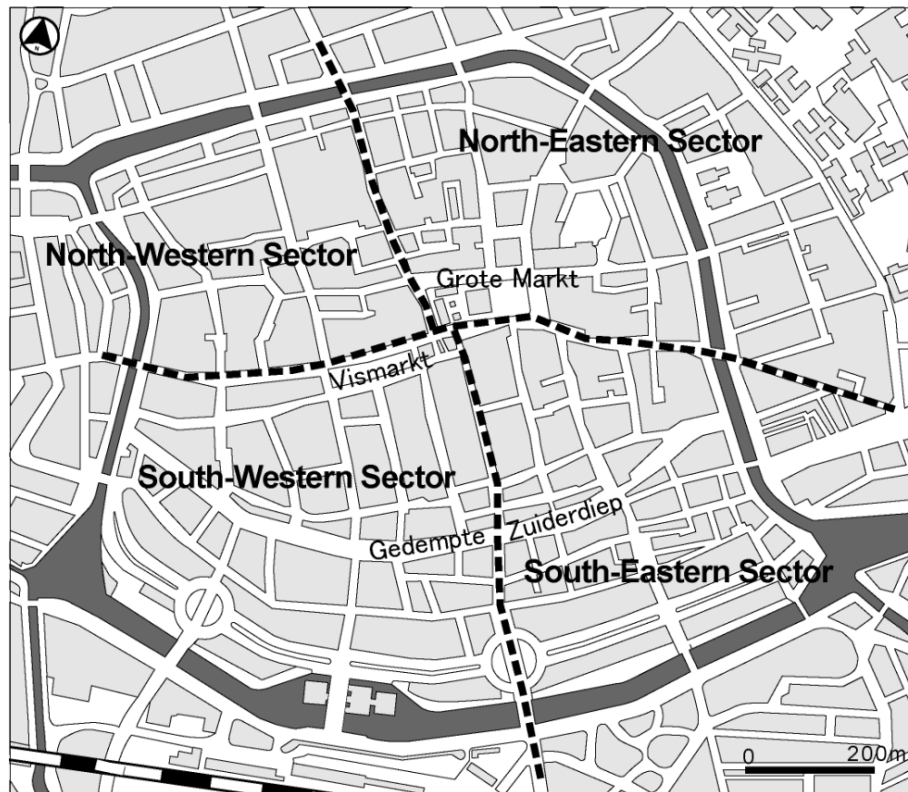


Figure 11. Groningen's Traffic Circulation Plan. Source: Tsubohara and Voogd, 2004.

What makes Groningen such a great cycling place was the establishment of *Verkeerscirculatieplan* ("Traffic Circulation Plan"), that divided the city centre into four quadrants (as shown in Figure 9 above) where cars were forbidden to cross between those quadrants. (Bruntlett and Bruntlett, 2018, Tsubohara and Voogd, 2004).

According to Lior Steinberg, founder of the urban change agency, Humankind, (source) the brilliance of Van de Berg's *verkeerscirculatieplan* is that you don't notice its existence when one is on foot, bike, or bus, but is very evident when you try to drive. Virtually from any point to any other point within the city it is faster to get there by bicycle than by car. As Stienberg notes, "This is something that is quite rare elsewhere. Even in bigger cities where they are investing in cycling and it is catching on as a mode of transportation, it's still often faster to go by car... It might be more expensive, it might be less comfortable, but it's still faster. The circulation plan made cycling faster." (Bruntlett and Bruntlett, 2018 p. 50; Steinberg 2014).



Figure 12. The world's largest bicycle parking garage in Utrecht Central Station. This infrastructure helps to solidify the bicycle as a marker of Utrecht's sense of place. Source: /u/gahte3 Reddit, 2019.

Placemaking in the cycling context can also mean the conscious placement of cycling-related amenities within a space, such as dedicated bike parking as shown in Figure 10 above (Porter, 2016). The addition of amenities demonstrates a level of thought and consideration that any given municipality can give to cycling if they hope to make the mode part of the identity of the place. As Chris Bruntlett stated in a LinkedIn post regarding Rotterdam's redesign of their street Coolsingel, "Design your street for the traffic you want, not the traffic you have." In that space, they have removed all but two car lanes, and in its place added a tramway, additional walking space, and of course, dedicated cycle lanes (Gemeente Rotterdam, 2023).

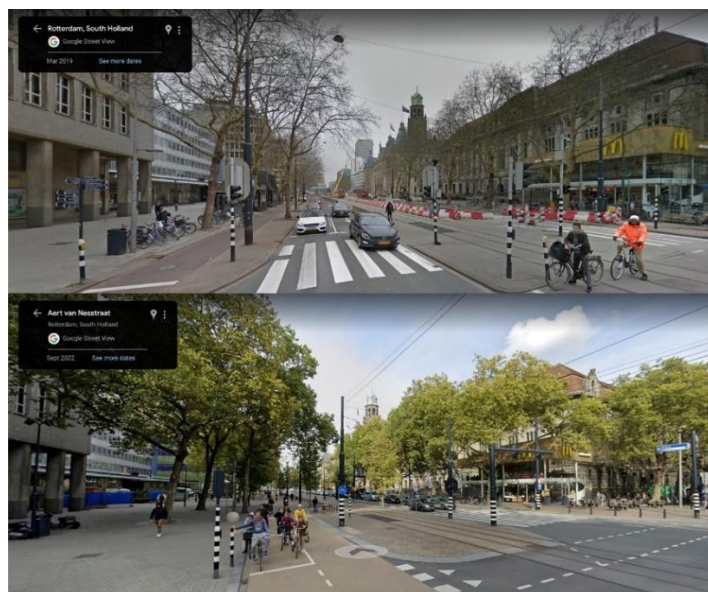


Figure 13. Coolsingel, Rotterdam, NL before (March 2019) and after (September 2022). Photo credit: Reddit user u/gandralph

### *3.2.2.1 Adaption to the Recreational and Rural contexts*

The adaptation of placemaking for cycling in the recreational and rural contexts has been a subject of immense consideration under the larger umbrella project of the Danish National recreational Cycling network that this internship-based thesis takes place under (*more on this can be found in the context section*).

In the case of recreational activities that encompass outdoor leisure, like cycling, investing more into amenities like dedicated cycling infrastructure, and parking spaces, help to cement the activity's role as part of the identity of the places, by improving access to recreation and leisure activities (Bruntlett and Bruntlett, 2018; Kruger, 2006).

Lessons can also be taken from rural placemaking. As seen from the perspective of the US Department of Agriculture (2023), the process is simply adapted to a rural context. In rural communities, just as in cities, a collaborative engagement process is needed to create quality place where people want to live, learn, work, and visit. Partners can be brought together from various sectors such as public, private, community, philanthropic or technology, if an all-encompassing approach to community and economic development is taken. Such an approach should ideally incorporate creativity, infrastructure initiatives, and vibrant public spaces.

The Rural America Placemaking Toolkit (2022) whose guide includes aspects such as creative community conversations, community and cultural assessment, public spaces and gathering places, cross-sector partnerships, and both technical and financial assistance directories, serves as a good example of how placemaking can function in rural areas.

One of biggest challenge to placemaking in rural areas is that the population density can often be too low to achieve critical mass (Lebisch et al., 2020, p. 10). To answer this challenge, nature can be used to improve people's impression on a place, and thus entice them to visit. Nature placemaking techniques like creating green corridors, accessible meeting places in nature, and providing enticing activities that encourage people to spend longer periods of time there, all help to provide real assets that can help to bolster their rural areas. (Lebisch et al., 2020, p. 57). Section 3.2.2.2 elaborates further on this idea of nature-based placemaking.

### *3.2.2.2 Nature-Based Placemaking*

Placemaking has been applied to various concepts and areas, like urban nature and community gardening (Truong et al., 2022), to participatory planning (Huang, 2019), tourism planning (Lew, 2017). A great example of nature-based placemaking (NBP), is a prioritization on the creation of trails, parks and other amenities that help support outdoor recreation. The non-profit organization Pennsylvania Downtown Center (2021) for example, attempts to examine how such amenities help to lift all of society, from improving the economy, to the quality of local life.

Another big factor mentioned in the creation of the NBP framework was the idea of 'Pride in Place' (Shaw, Garling and Kenny, 2022; Wherley, 2021). This derives from a family of similar phrases such as 'local' and 'civic' pride, with the idea being that if policies are implemented that help a community to be able take pride in their place, the community themselves are more likely to work and strive to take care of their local environment, thus maintaining this sense of place identity that they cherish (source). In the case of NBP, this is done by harnessing and leveraging a region's natural resources. This is not done by means of resource extraction or overdevelopment, but rather, a carefully managed kind of development around nature-based amenities and recreation, like that of hiking and biking trails, nature and community centres, biking, and water sports rental services, etc. (Wherley, 2021).

“Trails and vibrancy go hand in hand” as stated Amy Camp from Cycle Forward (Wherley, 2022). She continues, “...what trails do is that they start to bring new life into communities, and a lot of times are bringing in new people as well.” Such lessons from NBP techniques could potentially be transferred to cycling networks with a particular focus on recreational cycling, as that focus point for leisure and amenity-building can help to contribute to vibrancy, thus bring new life and people to an area. More on this connection to vibrancy shall be discussed in the next section.

### 3.3 An Overview of Urban Vitality

Urban Vitality is a diverse concept with many interpretations. By some accounts, Urban Vitality is the quality of spaces within cities capable of attracting a diverse array of people for different activities throughout varied time schedules (Kang, Fan and Jiao, 2021). Conditions used to contribute and quantify high urban vitality include space-use diversity, opportunities for personal contact, diversity of buildings [landscapes], high population density, accessibility (particularly for pedestrians, followed by cycling and public transport), and distance to border elements that discourage use of the street (Liang et al., 2022; Wang et al., 2022). Section 3.3.1 below discusses urban vitality in relation to cycling.

#### 3.3.1 Urban Vitality and Cycling

When we think of what factors could connect urban vitality and cycling, by some interpretations at least it would have to encompass the qualities of spaces that could attract a diverse array of people to participate in cycling during various time schedules (Bruntlett and Bruntlett, 2018). To the best of my knowledge a limited number of works have been written that directly and clearly spell out the link between cycling and urban vitality, yet publications such as Zhang et al., (2020) and Lunecke and Mora (2017) have made the links between urban vitality and walking through evaluations of the street block level and pedestrian networks. According to Lunecke and Mora (2017), it is postulated that Infrastructure networks, like pedestrian networks (or for the purpose of this thesis, cycling networks), are spaces of mobility and flow which “work to bring heterogeneous places, people, buildings and urban elements into dynamic relationships and exchanges which would not otherwise be possible” (Graham and Marvin 2001, p. 11).

Section 3.3.1.1. below elaborates the CROW design principles which are significant for understanding how to enhance urban vitality.

##### *3.3.1.1 CROW Design principles as a contributor to urban vitality*

The Dutch CROW *Design Manual for Bicycle Traffic* (2016) is a bicycle traffic planning manual used both worldwide (Wicks, 2014) including the Netherlands (Shahan, 2017; Hull & O’Holleran, 2014). The manual describes 5 design principles for bicycle infrastructure namely, cohesion, directness, safety, comfort, and attractiveness. These design principles were developed with transferability in mind, and hence were made to be adapted to local contexts. The idea being that applying these principles will lead to safe and successful bicycle infrastructure (Gorris, 2023). This can help plant the seeds, to further develop, or strengthen an existing cycling culture, thereby adding vitality to this aspect of a given place.

## Cohesion

Cohesion, in the sense of forming a united whole (Oxford, 2023), is created through developing a network where cyclists are able to cycle from A to B. From anywhere to everywhere, if the bicycle is to be taken seriously as a means of transport.

### COHESION: Connecting origins and destinations Cycling from anywhere to everywhere

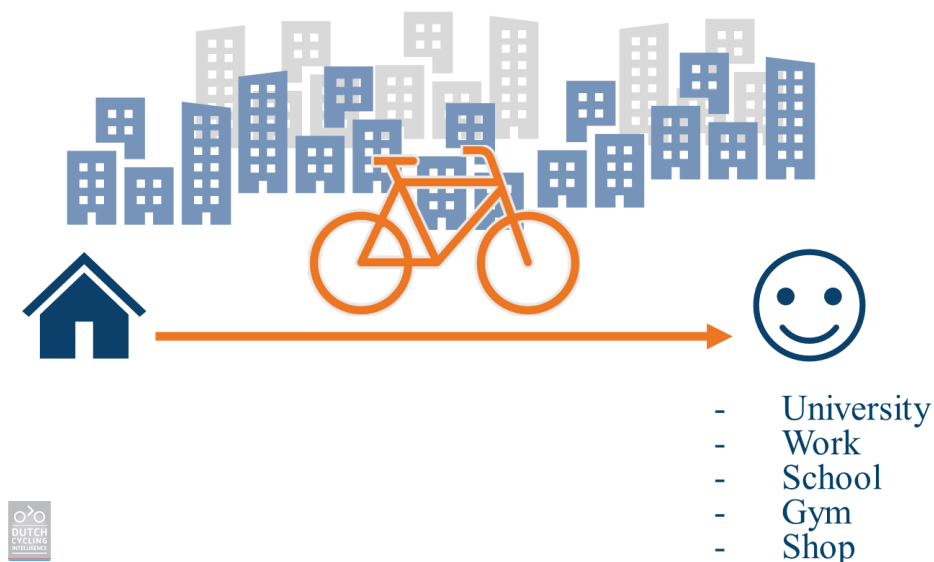


Figure 14. CROW principle Cohesion. Source: DTV Capacity Building, 2023

Cohesion creates the possibility to get somewhere by bicycle. Where a single-mode trip or multi-modal that involves cycling to public transport hubs. In other words, cycle friendly infrastructure should “form a cohesive whole and link all origins and destinations that cyclists may have” (Gorris, 2023; Dutch Cycling Embassy, 2021a).

Cohesion helps to connect all necessary elements ensuring that a door-to-door trip is possible using a bicycle.

## Directness

Directness in this case is defined as the quality of being plain and straightforward (Oxford, 2023). Cyclists should be offered as direct a route as possible keeping detours to a minimum. This principle is relevant to ensure fast connections and minimal delays that in turn allow the bicycle to become a competitive transport mode.



## DIRECTNESS: Creating short and fast routes Minimising detours

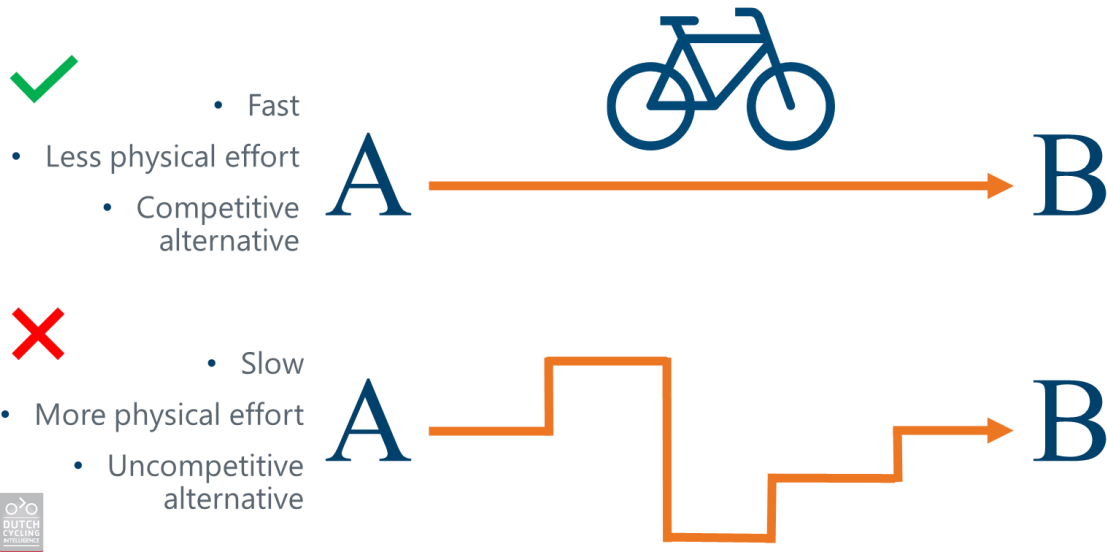


Figure 15. CROW principle Directness. Source: DTV Capacity Building, 2023

In planning for directness, one must account for distance and time, prioritizing short and fast routes. Short routes can be created at the network level, by providing connect and sufficiently dense bicycle networks. To reduce journey times, one must develop routes without delays. Measures like one-way streets for cars that allow contra flow for cyclists or routes used exclusively by cyclists and pedestrians help in this regard.

By reducing cyclists' average commuting time through the application of this principle, planners could promote bicycle use. Particularly in congested urban areas, such changes can prove to make the bicycle competitive with the car (Gorris, 2023; Dutch Cycling Embassy, 2021c).

### Safety

The principle of safety, defined as being protected from danger, risk, or injury (Oxford, 2023), can be thought of in a two-pronged manner of road safety and personal health. For instance, exposure to pollutants and noise may be minimized while also reducing stress.

Infrastructure should guarantee the safety of cyclists as well as other road users. Bicycle infrastructure should strive to avoid differences in speed and mass as much as possible.

## SAFETY: Avoid differences in SPEED and MASS Create homogenous traffic flows

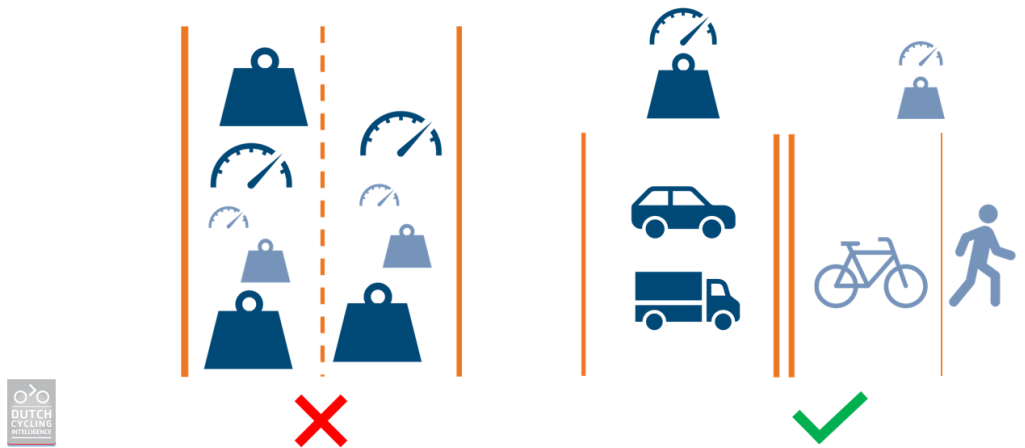


Figure 16. CROW principle Safety. Source: DTV Capacity Building, 2023

At the street design level, different vehicle types should be segregated by providing dedicated cycle lanes, or other forms of physical separation. Solutions like tunnels and bridges can be used at the intersection level, particularly for roads with high traffic volumes, speed limits, or both.

This principle also applies at the network level. Links should be planned in such a way as that accident risks, emissions, exposure, noise, and stress are avoided. Thereby, when possible, links should be planned along quieter streets as opposed to next to busy arterial roads. Traffic volumes are lower, and more space and capacity are available to realise safe bicycle infrastructure design (Gorris, 2023; Dutch Cycling Embassy, 2021d).

### Comfort

It is human instinct to seek comfort, yet infrastructure engineers have a tendency to overlook this principle.

## COMFORT: minimal stops or nuisance



Figure 17. CROW principle Comfort. Source: DTV Capacity Building & Dutch Cycling Embassy 2023

Comfortable cycling infrastructure should ensure that cyclists experience minimal stops or nuisance. Just as with the safety principle, planning links on quieter streets can help cyclists avoid nuisances like noise and exhaust fumes. Smooth pavement is an important solution at the street design level. Just as with the directness principle, network links should avoid detours, stops, and reduce bends, as cycling

requires physical effort one typically wants to avoid unnecessary extra effort (Gorris, 2023; Dutch Cycling Embassy, 2021b).

#### Attractiveness

This principle can tend to be more subjective, as it is influenced by many elements. What is considered attractive to one, may be viewed as unattractive to others, hence pushing some individuals to cycle, while being a reason not to for others. This creates challenges to the adaptation of this principle. However, some evidence and practical guidance do exist.

## (UN)ATTRACTIVENESS



### ATTRACTIVE

- **Green**
- **Open**
- **Water**
- **Well maintained**
- **Quiet streets**



### UNATTRACTIVE

- **Traffic**
- **Congestion**
- **Industry**
- **Dark / unlit**

Figure 18. CROW principle Attractiveness. Source: DTV Capacity Building, 2023

Research shows (Subiza-Pérez et al., 2019) that cyclist generally find green, open spaces, water and aesthetic qualities of the built environment attractive. Congestion, exhaust fumes, subjective risk of accidents or to personal safety are considered unattractive.

To apply this at the network level, one should: plan links through lively and/or green areas, and avoid planning links in deserted, dark, or industrial areas. When these are not possible, measures to improve street design like lighting, providing street furniture, and art should be considered to make routes more attractive. (Gorris, 2023; Dutch Cycling Embassy, 2021).

### 3.3.1.2 *Adaption to the Recreational and Rural contexts*

As was previously mentioned in the introduction, the Netherlands has 35,000 km of dedicated cycle track laid out across the country (CROW Fietsberaad, 2014). Furthermore, this development is not only concentrated within urban areas, but runs between cities, towns, and villages as well, making rural regions a valuable part of the cycling network too. Many these bicycle roads are part of the *Dutch National Cycle Network*, which is a network of bicycle tourism paths that reach all country's remote places. (Alex, 2022). Relative to other cycling contexts, the Netherlands has very strong urban-rural connections, as the same measures of road hierarchy and modal filtering are applied to the countryside as to the city (Bicycle Dutch, 2021).

Recreational cycling in the countryside is a very popular pastime in the Netherlands, thanks in part to an elaborate system of cycle junctions. Each of these cycle junctions are numbered so you can ride to the next by following the signs., making it possible to conduct tours without the need for one's own map or the use of GPS (Bicycle Dutch, 2021; Staples and Staples, 2013). Such wayfinding measures help to significantly reduce the barrier to entry for those interested in cycling for leisure purposes.

Part of this vitality present within the Dutch rural context is the tendency of these spaces to be multifunctional in nature, often out of necessity. While some landscape functions are affected negatively by the presence of others, functions such as leisure cycling and tourism seem to mutually benefit from this multifunctionality (Willemen et al., 2010). Cycling from town-to-town is still perceived as pleasant by some, even when there is no dedicated cycling infrastructure, thanks in part to nationwide traffic calming policies (Bicycle Dutch, 2021; Weijermars and Wegman, 2011).

Having explicated the concepts of flow, placemaking, vitality, their subsequent sub-types and contributing factors, the following sections shall now attempt to highlight connecting perspectives of these theoretical concepts and frameworks.

### 3.4 Connecting the theoretical concepts and frameworks.

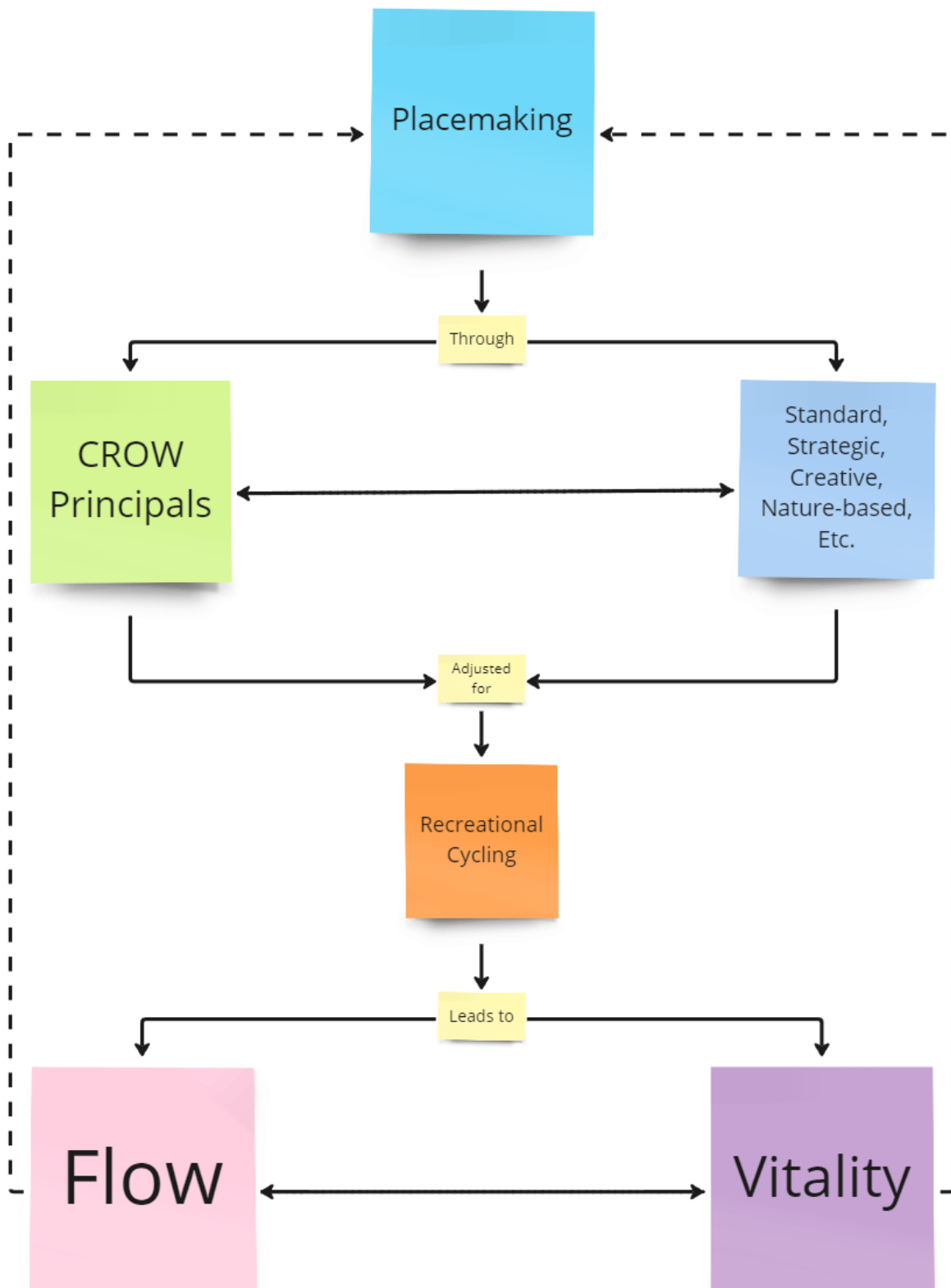


Figure 19. Figure 19. The Placemaking-Flow-Vitality Relational Framework within the Context of recreational cycling. Source: Author created via Miro (2023).

The theory chapter presented the concepts of flow, placemaking, urban vitality as well as the CROW design principles. Through connecting various concepts and frameworks presented within the literature review, the author presents perspectives on connecting flow, placemaking, and vitality within the recreational cycling context. When in the process of developing a recreational cycling network, one may think of placemaking as the foundational process and philosophy (Project for Public Spaces, 2019). Various styles of placemaking can be utilised depending on the timeline of the project and scale in which the planning is taking place. For instance, at the network level, standard placemaking could be primarily utilized. On smaller scales of a given project, more focus may be granted to the different types of placemaking from strategic, creative, and/or tactical placemaking, depending on the given on the environment. These can be used in tangent with design principles like that from the CROW manual (CROW Fietsberaad, 2014; Gorris, 2023). Both these principles and processes must be adjusted to the context of recreational cycling, to better fit the unique needs and opportunities specific to this cycling context over others (like commuting and sports cycling). In the recreational context, this means that a network should foster a sense of place that is primarily safe, attractive, and cohesive. When appropriate, such a network should be relatively comfortable, and direct, as well (but these other principles should take priority, more in this in sections below).

If said CROW principles and placemaking techniques are applied appropriately, one should expect the resulting routes and network to offer ample opportunities for recreational cyclists to experiences flow, and in turn improve vitality in the area, by creating spaces with an appropriate level of stimuli (thereby less prone to non-ideal states within Flow Theory, such as stress or boredom) that people wish to spend time in (Wicks, 2014; Bruntlett and Bruntlett, 2018; Te Brömmelstroet et. al, 2021). Furthermore, said flow experiences and this ample vitality will help to bolster and foster more of the other. These newfound attributes thus serve to further solidify the place identity (Bonaiuto et al., 2016) present throughout this hypothetical recreational cycling network, thereby further contributing to this placemaking process. Ideally, a feedback loop is thus created that continues to strengthen this sense of place. Thus, providing a growing number of flow experiences to new and existing users, that increases, or at least maintains, this newfound vitality/vibrancy in the area. These perspectives shall be returned to and examined in greater detail with the discussion chapter.

## 4 Context: Zwolle Proof of Concept and Denmark project

This section breaks down why Zwolle, the Netherlands was chosen as the context to test out these proof-of-concept trials. Here the relevance that this has for this thesis is elaborated. This in turn requires elaboration on the development of Denmark's National Recreational Cycling Network project. This thesis serves as a smaller sub-project for this large multi-year project that Mobycon is a part of. The hope is that insights brought about by this proof-of-concept mix-methods approaches can help to inform another round of trials in Denmark. These in turn, may be helping to incorporate participatory psychological insights based on Flow Theory, into the set of tools that the planners and developers of this project can use to design better recreational cycle routes, and a better network all together.

### 4.1 Study Area: Zwolle, the Netherlands



Figure 20. Zwolle's Location within the Netherlands. Source: GuideofTheWorld (2023)

The process for why Zwolle was chosen as the site of these proof-of-concept trials is an interesting one, that requires some background context. Initially myself, supervisors, other colleagues, and partner organizations thought these first set of trials would take place somewhere in Denmark itself, likely in the Aalborg region. But upon a more careful consideration of the logistical challenges, of getting several of the team members and necessary equipment over to Denmark for a week of trials, my supervisor ultimately thought it would be cheaper and easier for us to conduct a first round of trials in the Netherlands. Mobycon already has several offices and locations to choose from as a base of operations: from offices in Delft, 's-Hertogenbosch, and Zwolle, to co-working spaces and several colleagues based out of Utrecht.

Once the decision made sense internally, we had a meeting with one of our partner/clients in Denmark to pitch the initial Proof-of-Concept run in the Netherlands, with an optional second round of trials in Denmark, to be conducted depending on if they deemed the results of these trials as demonstrating

potential use for their purposes. They accepted the proposal, and thus the work was on its way to make the logistical preparations such as determining where and how the route could be developed.

All the other cities mentioned above were also considered in our process for making the route, but Zwolle was ultimately chosen as it best met the criteria we were looking for. Thus, we hoped it could better reflect, in some respects, the context in Denmark, even if the differences will still nonetheless be notable. More on this in the next section below.

#### 4.1.1 Introduction to Zwolle as the selected study area

Zwolle is a city in the North-eastern part of the Netherlands. It is the capital of the province of Overijssel and the province's second-largest city with a population of over 130,000 (StatLine, 2023). The city borders the province of Gelderland and sits directly east of the river IJssel. Due to its location next to this river, and consequently relatively easy access to the North Sea, Zwolle became a member of the Hanseatic League. Hence, trading has shaped its history and by consequence, its urban form, with the original city (what is now city centre) was designed as a fort city (Simplicius, 2007).



Figure 21. Historical Map of Zwolle by Joan Bleau in Bleau's "Tooneel der Steden", 1652

By train, it is located 50 minutes away from Utrecht, a city that sits roughly in the centre of the country, and by extension just an hour and 23 minutes from Amsterdam Centraal (NS, 2023).



Zwolle was ultimately chosen as our study area for several key reasons. First, Mobycon had an office there, that was very easy to commute to, as it was located just a 10-minute walk south of the train station.

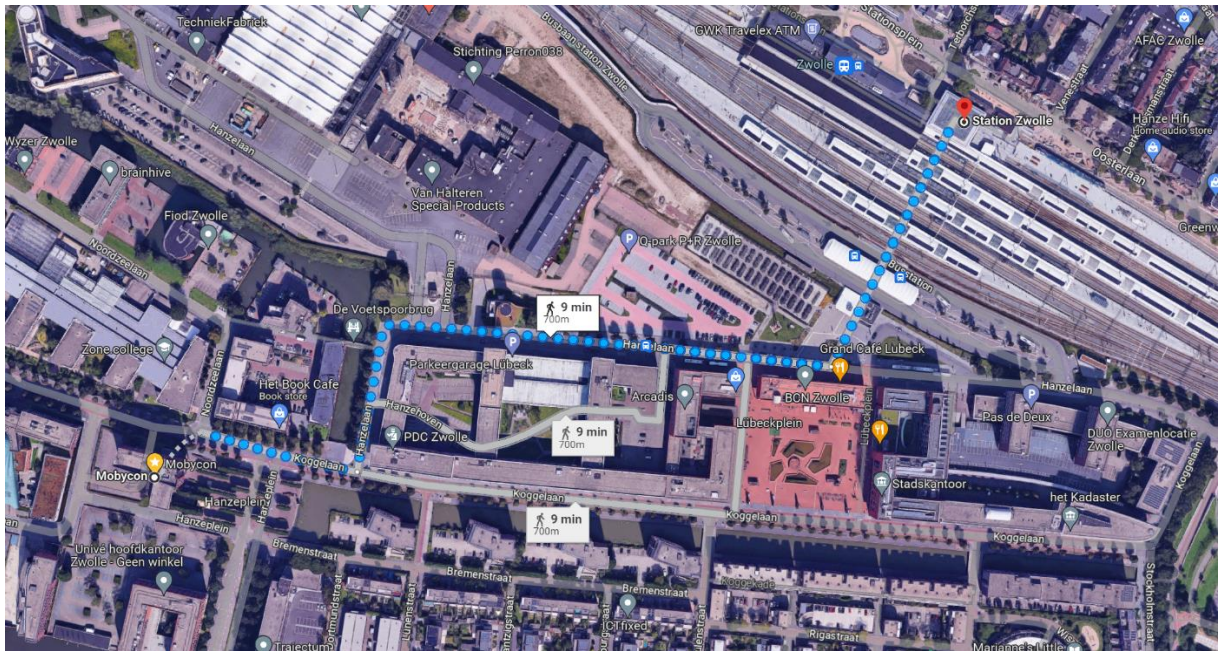


Figure 22. Distance and location of Mobycon office respective to Station Zwolle. An extra minute should be accounted for since the office on the 8th floor of the building. Source: Self-produced images via Google maps.

Second, the location of this office made it easy develop a route that was straightforward, yet at the same time took participants through a diverse array of environmental settings to cycle through. With the other potential locations, it proved difficult to develop a route that included cycling in an urban, semi-urban, countryside context without making the route itself unreasonably long, complicated or both. With some of the other potential options may have been able to achieve a route that served two contexts well, but not all three. These factors thus, made for a convenient base-of-operations from which to run the trials.

#### 4.1.2 Description of Zwolle's urban characteristics and development

Zwolle is an intriguing spot for recreational cycling development trials as despite not being as well-known in the cycling space as other Dutch cities like Amsterdam, Utrecht, or Groningen, Zwolle manages to garner an impressive bicycle mode share of 47% (Bruno, 2022; KIM, 2014). By some accounts Zwolle may even have the highest cycling mode share in the world, though this remains in constant flux (Tjepkema, n.d.; Gemeente Zwolle, 2023).

The Kennisstituut's mobility report for the Netherlands (2014) breaks down this mode share even further by trip purpose.

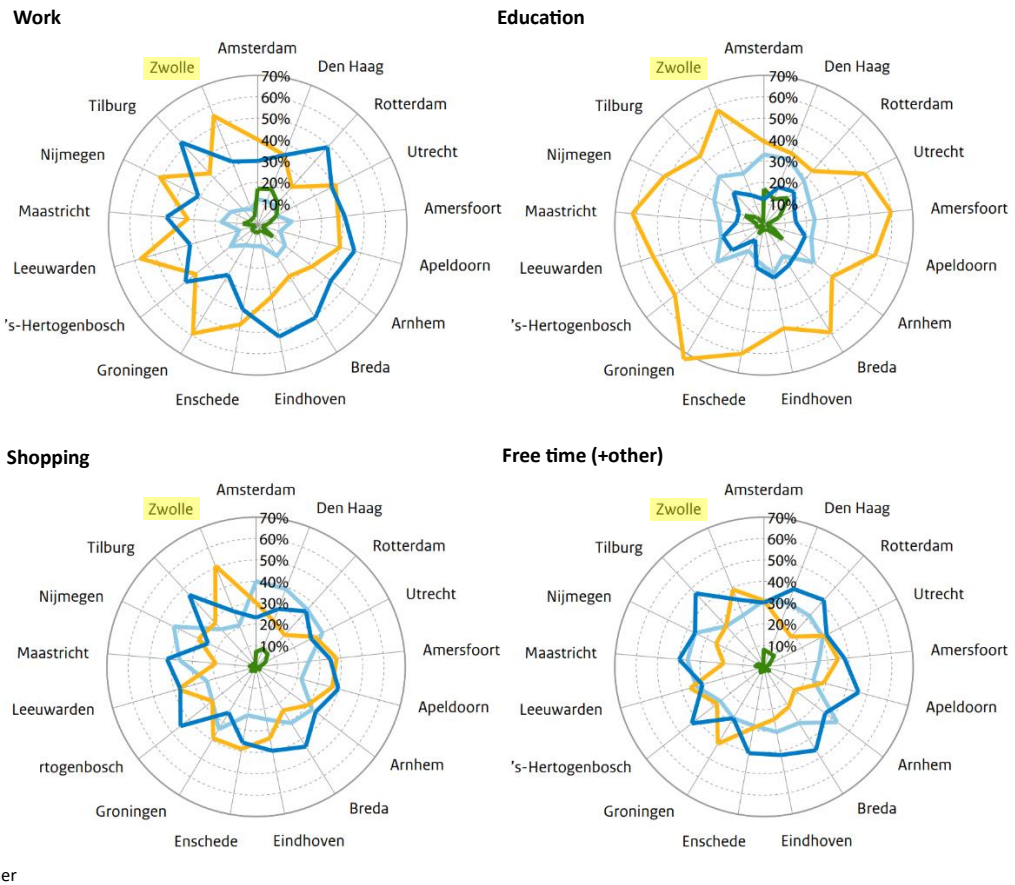


Figure 23. Modal split of all 'local' trips in 17 metropolitan agglomerations by motive. Source (Translated) CBS, OVIn 2011-2013; edit KiM.

In Zwolle, cycling mode share remained high for all trip purposes, above 50% for work, education, and store trips, and up to 40% for free time and other trips (KiM, 2014).

The municipality has a total area of 119.36 km<sup>2</sup> and a density of about 1.169/km<sup>2</sup> (CBS Statline, 2020 & 2021). In 2014 the urban extent of Zwolle was 4,322 hectares (43.22 km<sup>2</sup>).

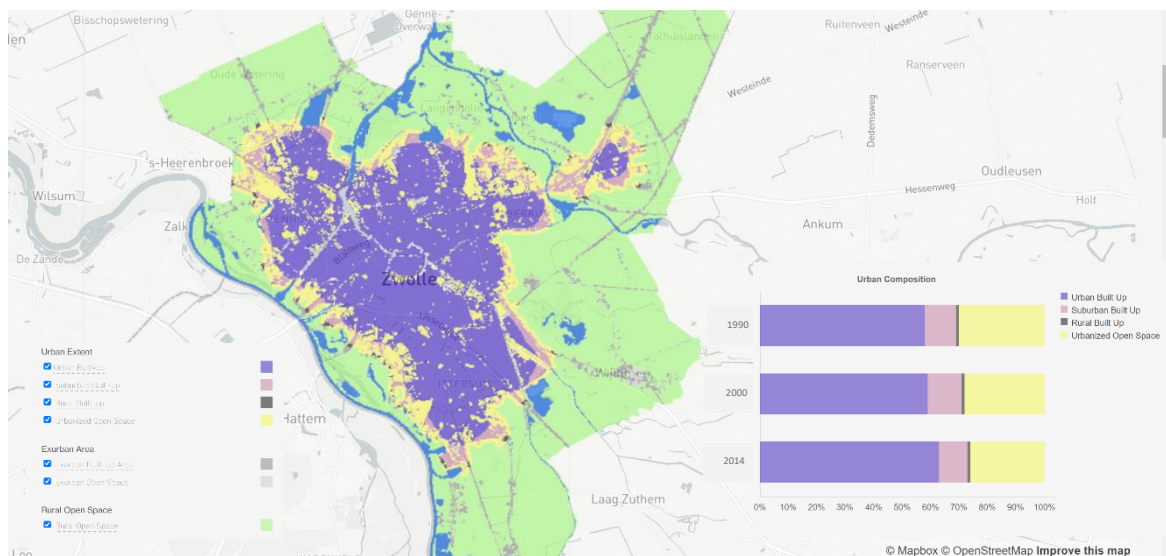


Figure 24. Zwolle 2014 Urban Extent, Source: Atlas of Urban Expansion (2016)

Of this area, 63% was classified as urban built up, 10% suburban built up, 1% rural built up, and 26% urbanized open space (New York University, UN-Habitat and Lincoln Institute of Land Policy, 2016).

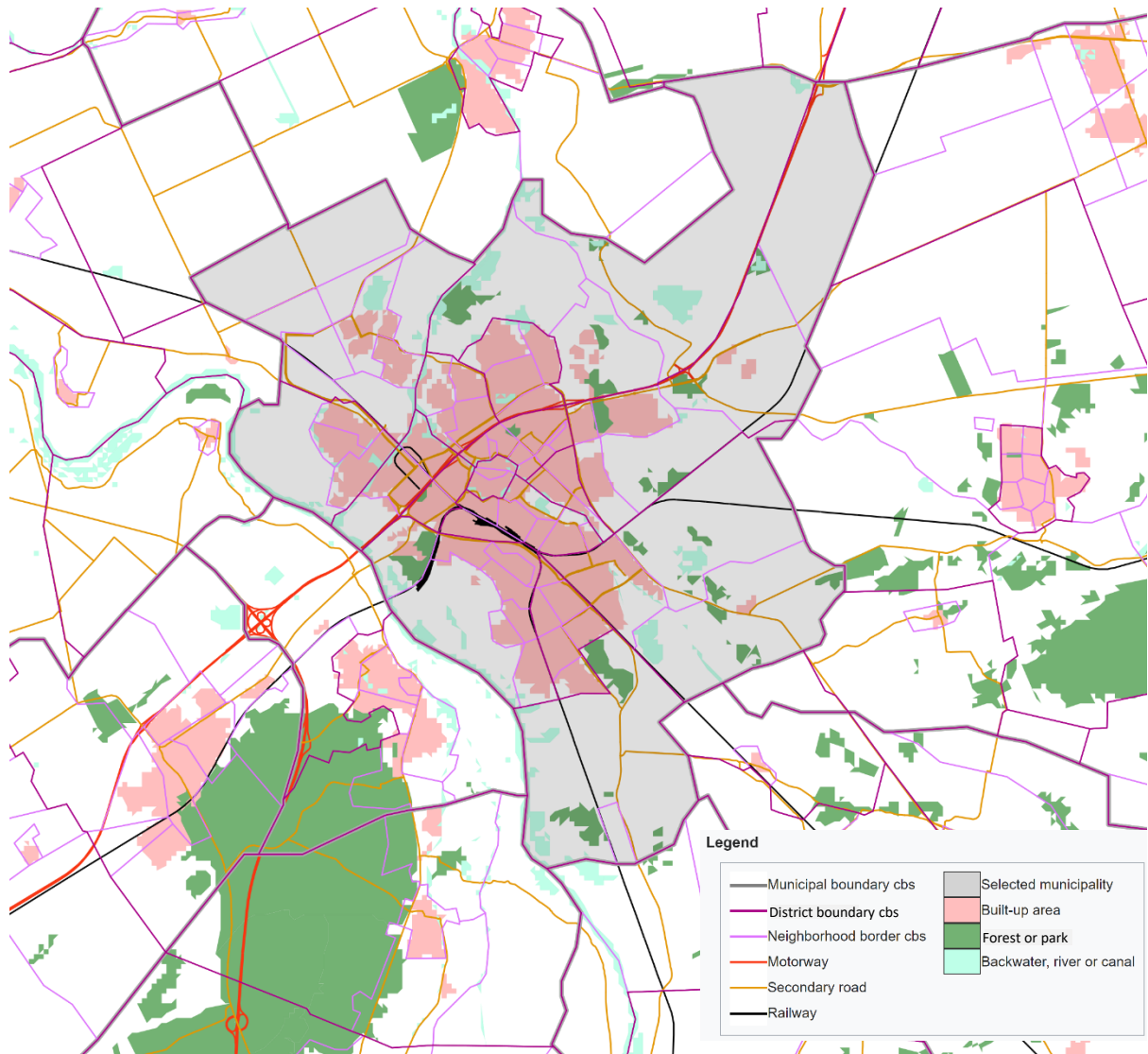


Figure 25. Zwolle and its surrounding boundary levels, road and rail infrastructure corridors, greenery, and bodies of water  
Source: (Centraal Bureau voor de Statistiek et al., 2009)

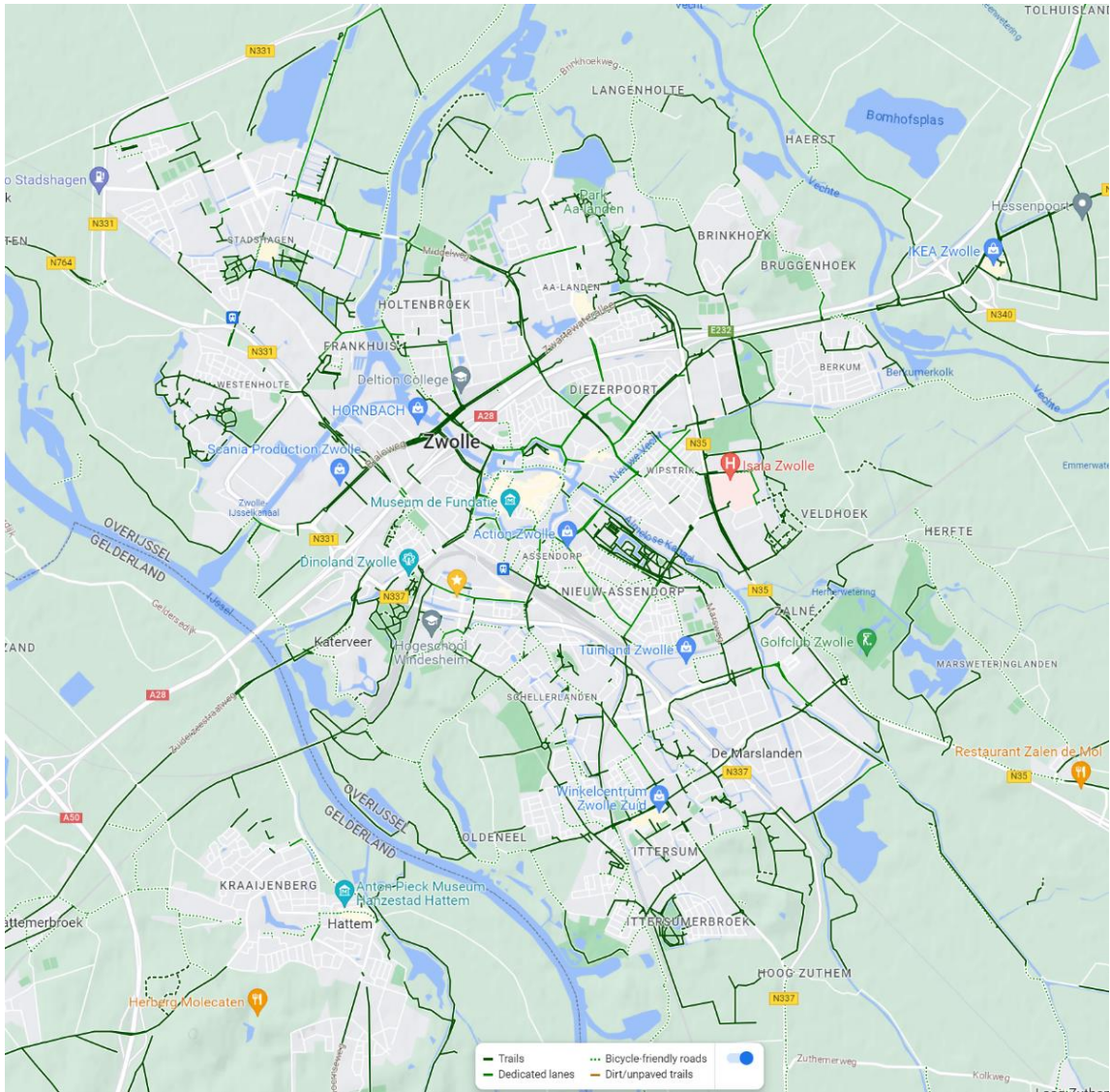


Figure 26. Density of Zwolle's cycling network. Dark green represents dedicated cycle path. Source: Self-produced image (2023) via Google Maps

Since the 1970s, Zwolle has worked hard to remove barriers to cycling. A very dense network of direct cycle routes, with no detours, has been created through the city, with no detours. Many dedicated cycling lanes, tunnels, bridges, have been built through out the area, along with special high-speed route to smaller satellite cities like Hattem (Bicycle Dutch, 2014).

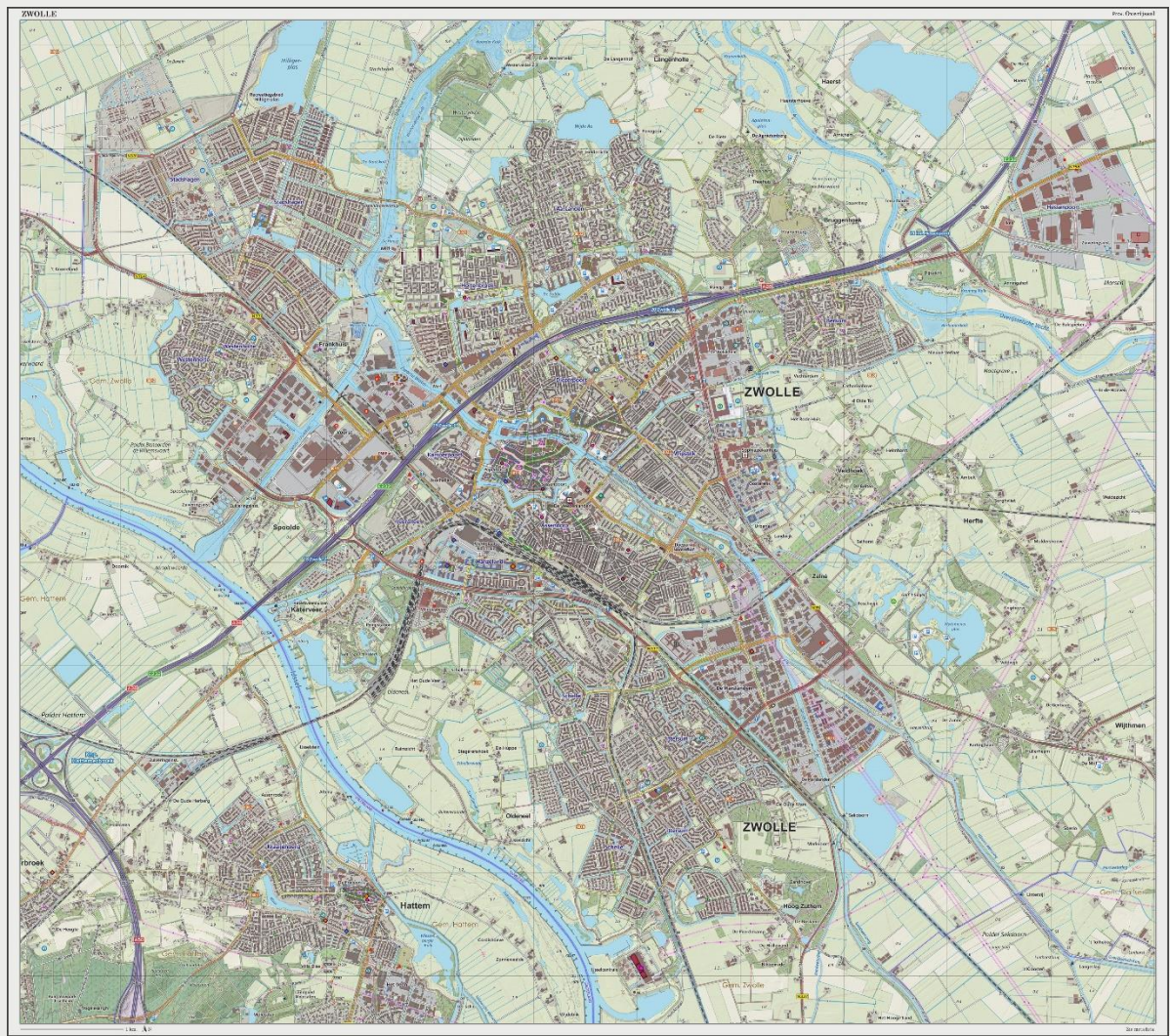


Figure 27. Residential map of Zwolle. Photo credit: Jan-Willem van Aalst

#### 4.1.2.1 Overview of the current state of placemaking and urban vitality in Zwolle

According to the municipality's website (2023), Zwolle plans to utilise the idea of placemaking to do more with creativity and culture within their outdoor spaces. Therefore, many more spaces shall be offered up to temporary creative initiatives, in attempt to make the city more fun and cosier. While it not stated directly, urban vitality is suggested here, the municipality strives to "bring places to life". Many of these outdoor areas, identified for such placemaking opportunities are located in the city centre, the Nieuwe Veemarkt, the Noorderkwartier and the Spoorzone, as these areas have many other developments taking place, and thus already have many visitors coming to these locations (Gemeente Zwolle, 2023).

### 4.1.3 Introduction to the selected course route



Figure 28. Finalized route used for these trials. Photo credit: Lennart Nout & author

After some careful consideration of the options, it was ultimately decided to go with this route selection pictured above. It offered the right balance of different cycling contexts (urban, semi-urban, and rural sections), and simplicity (participants only really have to make right turns, expect for a small left on section 1 to get onto the bicycle lane), whilst not being too long (participant could reasonably complete the course in 20 minutes or less). Section 1 ran primarily through a relatively modern urban area. Section 2 was surrounded first by a semi-urban neighbourhood and gradually transitions to more rural surroundings. Section 3 consisted of rural and natural surroundings. Section 4 consisted primarily of industrial surroundings, as it ran along a railway.

Below each section shall be broken down further to paint a better picture of their respective contexts.

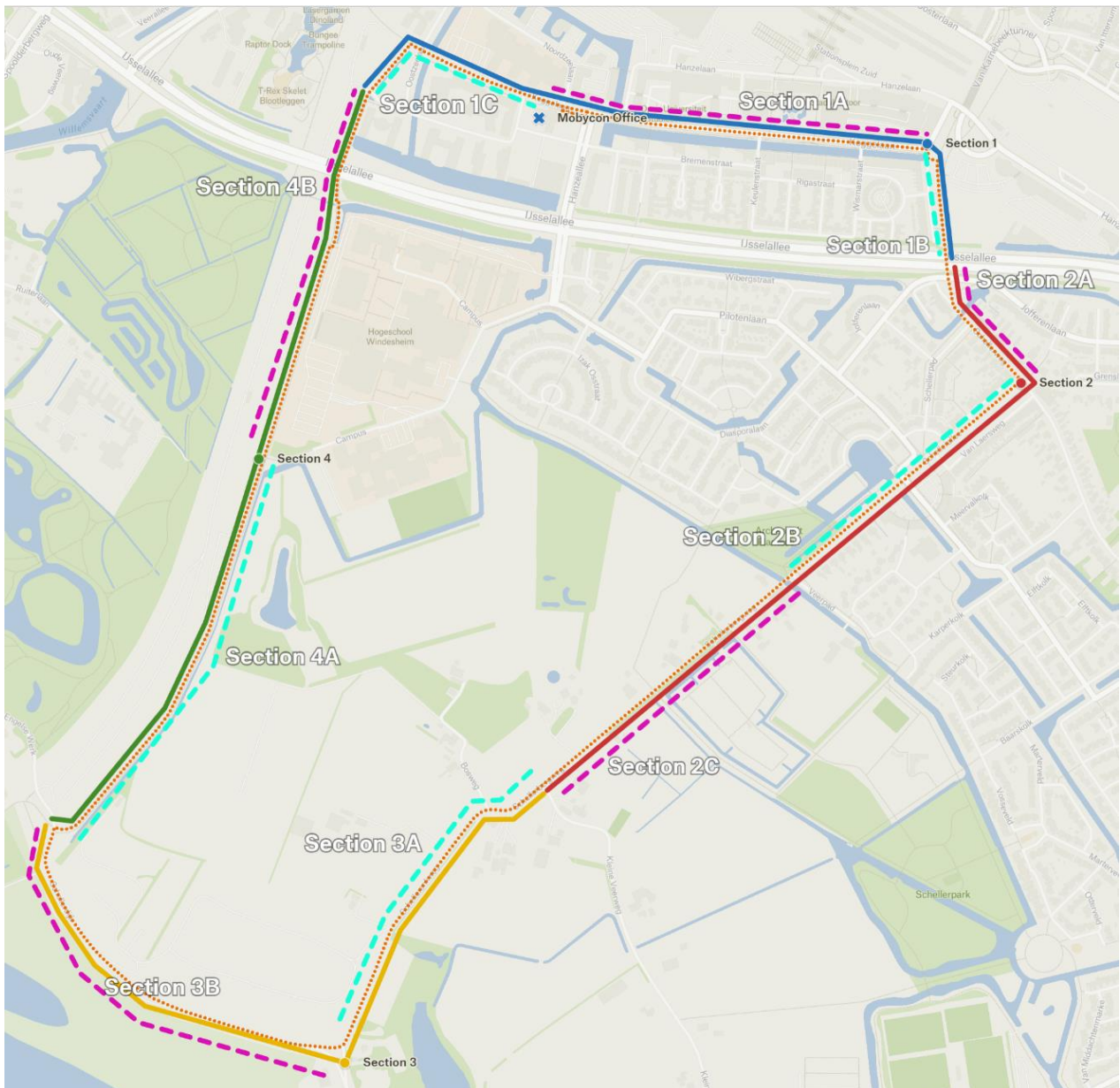


Figure 29. Subdivided Route for further analysis. Photo Credit: Author

The route was further divided into sub-subsections, for further analysis. Based on some of the aspects highlighted by various participants during the interactive interviews, certain smaller sections of the course and the interplays between them became particularly interesting to investigate further. More on this in the results section.

#### 4.1.3.1 Section 1

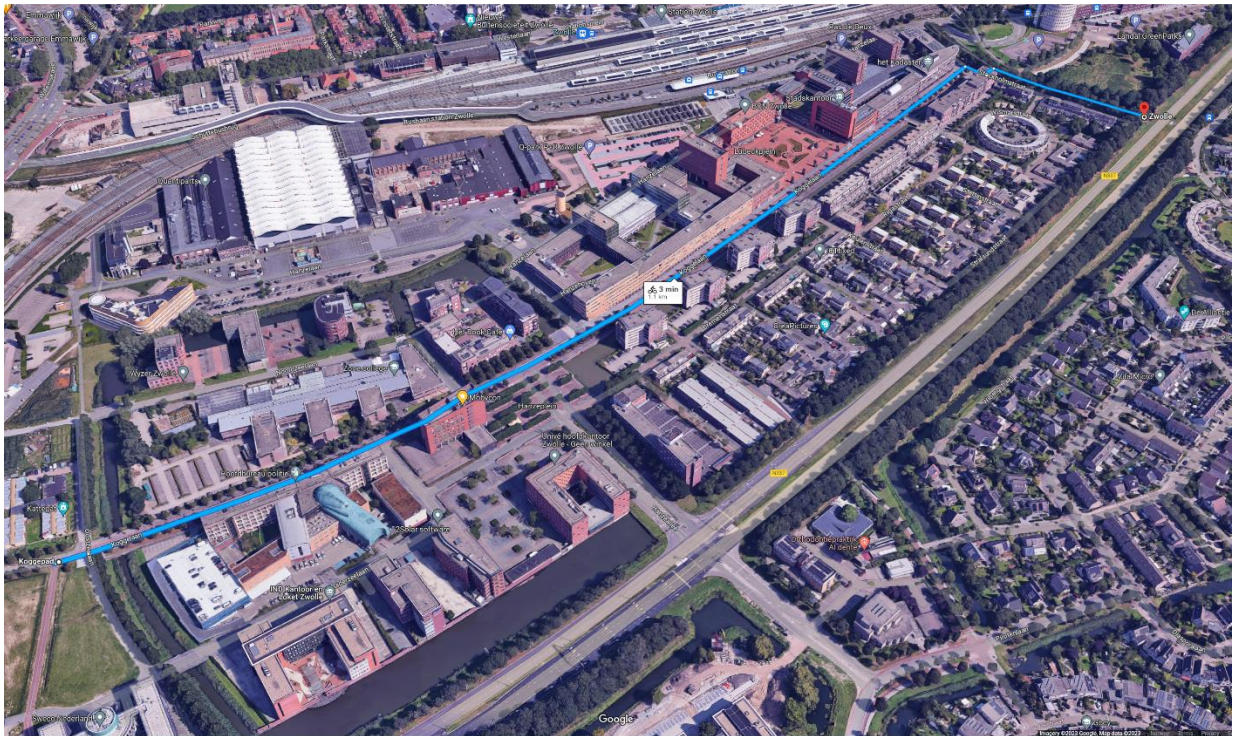


Figure 30. Overhead view of section 1. Photo credit: self

Section 1 is the most urbanized part of the route. It is characterized by medium-high density residential and office buildings. Relative to city centre, this is a much newer form of development, with many of said buildings being constructed in a modernist architectural style. The street, Koggelaan is characterised by red asphalt cycle lanes that are approximately 1.75 metres in length on each side, that share the space with motorized vehicle lanes.



Figure 31. On-street perspective of section 1, along Koggelaan. Photo credit: Screenshot taken by self (2023) via Google maps. Image captured March 2022.



The side of the street on which participants cycled along is characterized by a tree-lined area and a canal. So at least some elements of blue/green infrastructure are present along this section.

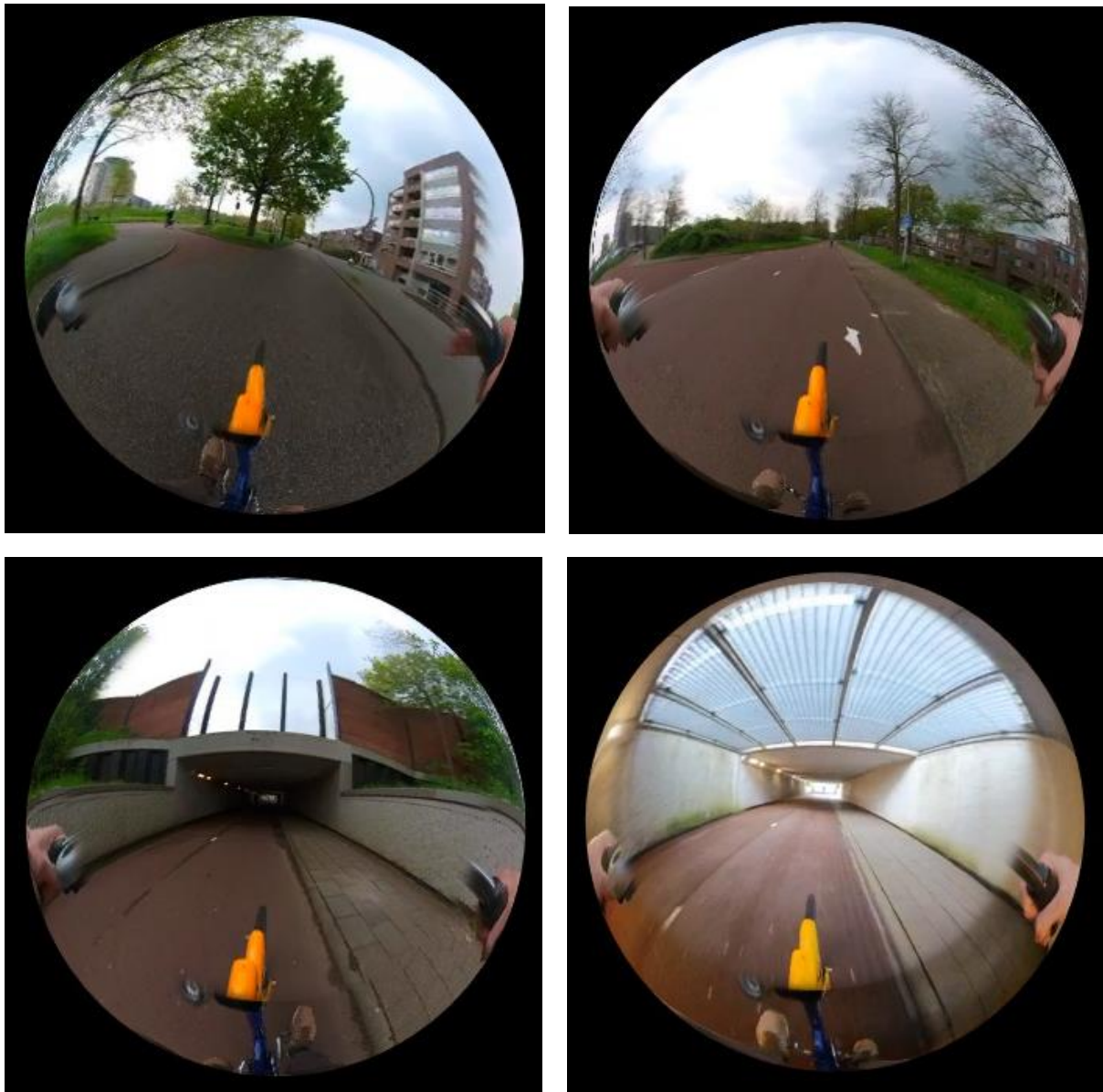


Figure 32. End of Section 1, onto the bicycle road and into the tunnel. Source: Self-produced screenshots from 360° camera.

The end of this section is characterized by a transition onto a bicycle road and then into cycling/pedestrian only tunnel. On this subsection participants no longer share the road with cars, they are on an over 3 metre wide fietspad (bicycle road), made of the characteristic Dutch red asphalt.

#### 4.1.3.2 Section 2



Figure 33. Overhead views of section 2. Photo credit: self

Section 2 is characterized primarily by a semi-urban neighbourhood, with some transition occurring to a more rural landscape by the end of this section. The first part of this section before the turn, along

the street Schellerweg, is characterized by a red asphalt cycle street. Cars are still permitted to drive here but the priority has been clearly made for cyclists, as can be seen in the image below.



Figure 34. On street perspective of Section 2 along Schellerweg. Photo credit: Self via Google maps.



Figure 35. On street perspective of Section 2 along Schellerallee. Photo credit: Self (2023) via Google maps. Image captured August 2021.

The section part of this section, along the street Schellerallee, is characterized by standard asphalt, with raised crossings at the respective intersections, and large trees providing shade to the cyclists and other road users. This subsection continues straight ahead until eventually reaching a sign stating that you are leaving Zwolle, after which the trees begin to sparse as one begins to enter the countryside.

#### 4.1.3.3 Section 3



Figure 36. Overhead views of section 3. Photo credit: self

Section 3 is characterized by country side scenery. There are two subsections one along the street Schellerallee, with a line of small young trees, dotting each side, and the other up on a dike, with views of the river IJssel, and a prominent bridge Hanzeboog that serves as a vital cycling and rail corridor for the region. This area hosts wide visas, with views of both agricultural and natural landscapes. Some farm animals were also present here on occasion, thus creating additional layering to scenery and potential things to look and take notice of when cycling for leisure purposes.



Figure 37. On street perspective of Section 3 along Schellerallee. Photo credit: Self (2023) via Google maps. Image captured March 2023.

While this subsection continues with the pattern of a tree-lined street present in section 2, the trees here are presumably much younger but definitely much shorter. Hence no tree canopy is present, shading this part of the course. Consequently little protection from weather elements like the wind or rain are provided.



Figure 38. On street perspective of the transition zone up onto the dike in Section 3 Photo credit: Self (2023) via Google maps. Image captured March 2023.

Transitioning from these two subsections, the asphalt pavement temporarily gives way to brick pavers, as one cycles up to get onto the dike. This creates another layer to both the experience of place and the experience of cycling here, as the texture of pavers often causes bicycles to rattle.



Figure 39. On street perspective of Section 3 along the street on top of the dike, Schellerdijk. Photo credit: Self (2023) via Google maps. Image captured August 2021.

Here up on the dike, is where likely cyclists experience the greatest sense of wide open space on the course. With agricultural land to one's right, and the IJssel River to one's left, cyclists are surrounded by naturalistic elements on all sides. Yet one is also most exposed to the forces of nature on this part of the ride as well. Rain, snow, hail, wind, or sunshine, this may often be the part of the course that such elements feel most present, or dramatic.

#### 4.1.3.4 Section 4



Figure 40. Overhead views of section 4. Photo credit: self

Section 4 is a long straight section that follows the railline. On the other side, one first encounters a line of trees adjacent to the path, then a small open field, before being met with the various buildings and park lot that make up the Hogeschool Windeheim complex. The cycling environment might be considered a type of cycling highway made up of large concrete slabs and concrete barrier that segregates the respective lanes of each direction. By the end of this section after passing under the bridge the route again transitions first to brick pavers, then to a fietspad for a short distance before turning back to the road and characteristics of section 1. The images below show this section in greater detail.



Figure 41. On street perspectives from along section 4. Photo credit: 1st image Self (2023) via Google maps. Image captured August 2021, Rest Self-produced screenshots from 360° camera.



## 4.2 The Danish National Recreational Cycling Network Project

Greater numbers of native cyclists and tourists from abroad are using the cycling routes in Denmark for recreational purposes. The project aims to create a national recreational cycling network, or *knudepunktsnetværk*, across Denmark, in the coming years, to better accommodate this recreational purpose within the existing infrastructure (Dansk Kyst og Natur Turisme, 2022). The network hopes to take inspiration other bicycle networks like what is present in other cycling friendly countries like the Netherlands, Germany, and Belgium.

Another big motivation for the project was to ensure such a *knudepunktsnetværk* is created not only *for*, but *by* the Danes. That way parameter can be better set for the Danish context. This is achieved through cooperation with local stakeholders and the Danish Cycling Federation.

### 4.2.1 Introduction to the larger project in Denmark

Mobycon has been contracted along with several other partner companies to help develop the network. Mobycon share responsibility for at least 3 major steps in the process:

#### 1. The Development of national principles.

Inspiration has been derived directly from the CROW guidelines, thereby the main principles that have been suggested are attractiveness – directness – coherence – safety – comfort.

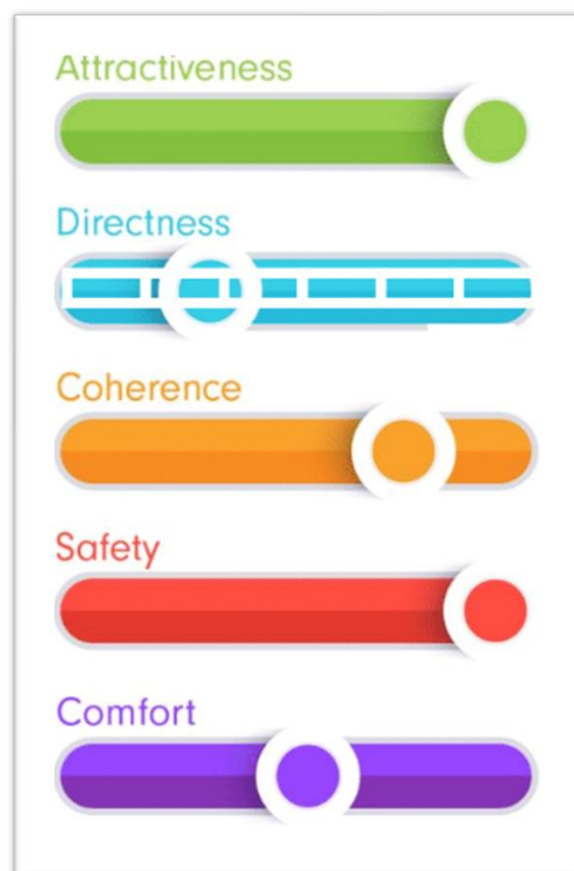


Figure 42. Suggested network principles and their suggested degree of importance. Source: Mobycon PowerPoint 2022

The principles vary in their level of importance, to better curtail to the recreational context. Principles such as attractiveness and safety get a high priority whereas directness is not nearly as important, as it is more important that recreational routes are fun, safe, and scenic, and is potentially able to repeatedly elicit those sensations than it is for the route to get cyclists quickly from point A to B like it is in the commuting context.

## 2. The planning of Networks in pilot regions.

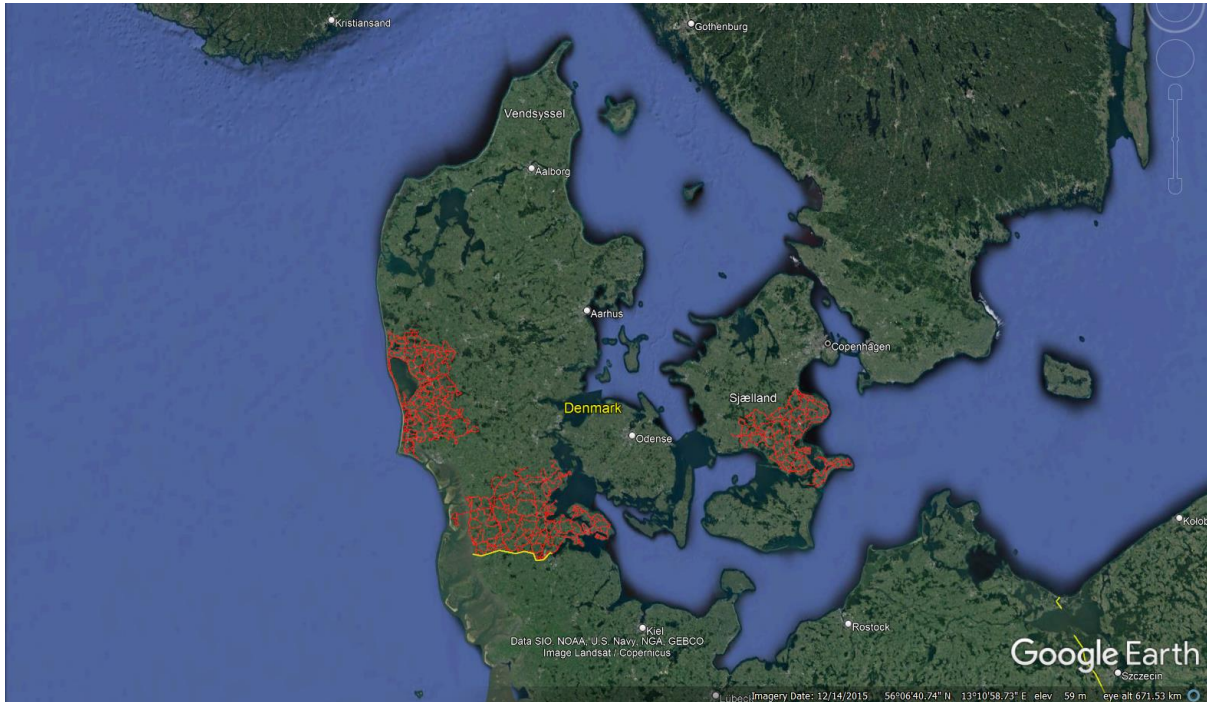


Figure 43. Pilot Regions of Danish National Recreational Cycling Network. Source: Mobycon using Google Earth 2022.

A series of pilot routes in three different regions of the country has already begun to be planned and proposed. I along with other Mobycon colleagues were tasked with overviewing the network, highlighting our critiques of the proposal. For instance, the client and some of the fellow partner companies on the project, have requested that the network be built utilizing as much existing infrastructure as possible, presumably this is motivated by primarily as a cost cutting measure. Mobycon takes the position that dedicated infrastructure, will make for a better more complete network as a whole. Some of the current route suggestions, run for long stretches on a bicycle pedestrian track along the highway.

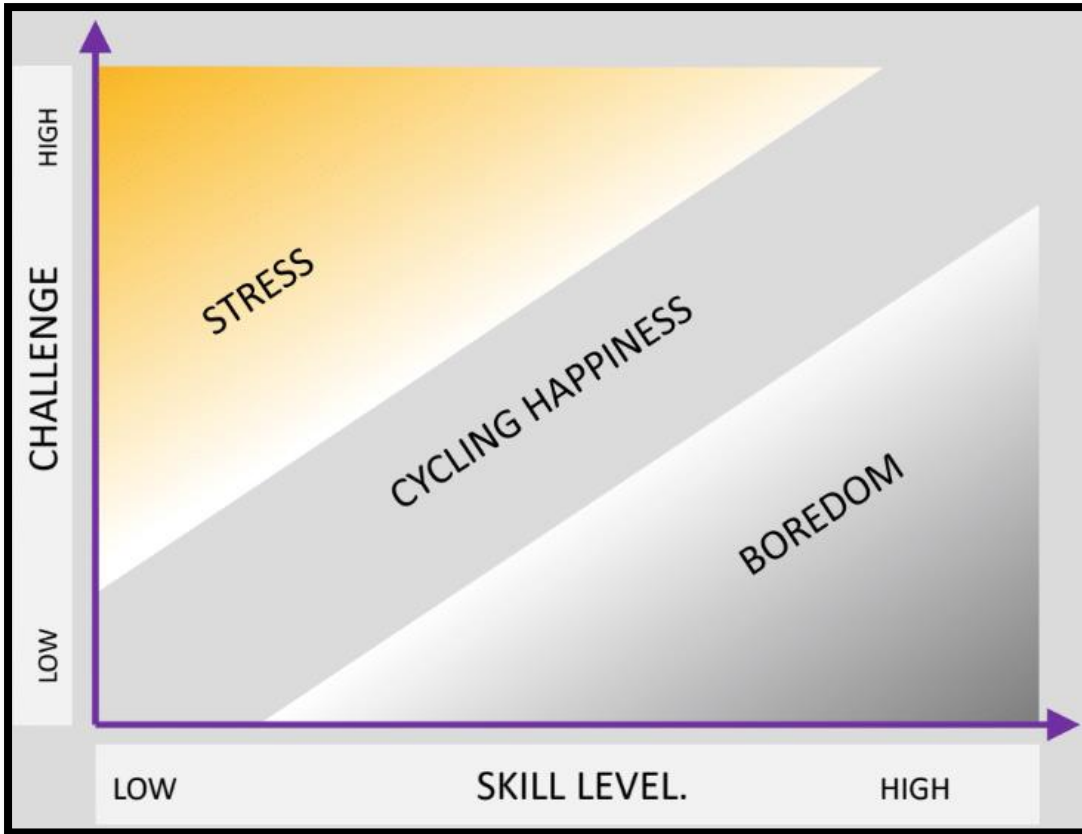


Figure 44. Flow balance in cycling. Source: Taken from a Mobycon presentation 2022.

Mobycon in part is attempting to utilise this flow-based framework, in tangent with the suggested principles, to make the route more interesting and vibrant as a whole. Hence the organization maintains the position that some degree of investment into more dedicated routes and infrastructure would be worth it to better ensure the success of the network.

Currently, in the pilot network proposal, some of these existing paths may elicit too much stress (like having to share the road with relatively fast motorized traffic) or may be too boring (dedicated cycle path running right along the highway). Thus opportunities are missed to increase metrics like the attractiveness and safeness of a network, by say instead opting to run the network through a forest patch instead of just in fields or along the road.

### 3. The decision document for national implementation.

Once the other steps are complete, Mobycon and partners plan to create a manual for a national roll-out. This manual shall consist of national principles and parameters for the *knudepunktsnetværk* with practical procedures of how to continue to develop and deploy a *knudepunktsnetværk* in the rest of Denmark (Dansk Kyst og Natur Turisme, 2022).

#### 4.2.2 Explanation of the project's objectives and scope

The end goal of this project is to create a national recreational cycling network across the country, that hopes to better accommodate the growing number of recreational cyclists within Denmark, and those coming to the country from abroad. When considering the scope of this network, it is reasonable to assume that a sizable portion of the network, if not an outright majority, will be set in the Danish countryside.

#### 4.2.3 Relevance of the project to the internship and urban planning thesis

As mentioned above, these proof-of-concept flow-trials serve a small part of this larger project, with the intention to see if a workable method can be developed that incorporates a flow-based framework into route optimization.

Despite Denmark also being quite a cycle friendly nation, with a similar geographic profile to the Netherlands, the context still has its differences. So as means to account for said differences, Mobycon and its partners plan to conduct further trials and testing within Denmark, contingent on the discoveries made during this round of trials. In this master's thesis data for these Denmark trials is not be included due to time constraints. Nonetheless, recommendations are made in the discussion section to help assist future research and trials with what might be important to consider (in terms of similarities or differences) when replicating this research in other cultural, geographic, and spatial contexts.

Furthermore, future contexts and use cases such as this, are important to keep in mind when considering the relationship that such a flow-based framework may have to placemaking, vitality, and planning as whole. This shall be further elaborated on in the discussion section.

## 5 Results

As previously stated, a total of 20 participants participated in these proof-of-concept trials. The qualitative data from all trials is useable. However, the same cannot be said about the quantitative data, as some malfunctions, errors, or other mishaps occurred from time to time with the camera and Emotibit sensor.

In addition, 4 expert interviews were conducted before the trials began. These were used to gain better insights into the potential connections between existing research related to flow theory and cycling, and how this may relate to the concepts of placemaking and urban vitality. Furthermore, recommendations from these interviewees were also taken into account to help enhance the methods, (like what was mentioned in the Insta360 camera section) in attempt to improve the quality of the trials.

### 5.1 Pre-ride Overview

The pre-ride questions consist of two parts. First 7 autotelic personality questions, derived from a 26-question autotelic personality questionnaire, were asked of participants during the sign-up process. An autotelic individual is defined as one who has an initiate sense of purpose (Heilala, 2022). Those with more autotelic personality traits tend to have an easier time entering a state of flow, and hence such questionnaires have often been used to measure individual's proclivity to flow (Tse et al., 2018; Nakamura & Csikszentmihalyi 2002). Second. Pre-ride questions were asked of participants the day of the trials before embarking on the cycle ride. These questions ranged from general demographic information, mood coming into the trial day, level of cycling experience, and cycling preferences. Results for these sections begin below:

### 5.1.1 Autotelic Personality Questions

Below are the results from the Autotelic Personality Questionnaire, presented to participants during the sign-up process, of which 17 of the 20 participants filled this out. The higher their total, the more likely that said participant is autotelic, thereby indicating that they are more prone to entering a state of Flow.

(Strongly Disagree = 1, Strongly Agree = 7)

Table 6. Results from Autotelic personality Questions per Participant. \* Last question is negatively scored towards total. Source: Self

Age Range:	18-29	18-29	18-29	18-29	18-29	18-29	18-29	18-29	18-29	30-39	18-29	30-39	18-29	18-29	18-29	18-29	18-29	18-29	18-29	18-29
Gender	F	M	F	M	M	M	F	F	M	M	F	M	M	F	F	M	M	F	F	M
Participant Identification #: Identified via Trial Day & Number (D# T#)	D1 T1	D1 T2	D1 T3	D1 T4	D1 T5	D1 T6	D1 T7	D2 T1	D2 T2	D2 T3	D3 T1	D3 T2	D4 T1	D4 T2	D4 T3	D5 T1	D5 T2	D5 T3	D5 T4	D6 T1
Curiosity is the driving force behind much of what I do.	6	6	NA	NA	6	NA	7	5	5	5	4	7	4	3	6	5	5	5	6	4
I perform tasks even when they are difficult.	7	7	NA	NA	6	NA	5	4	6	6	3	5	6	5	6	5	5	5	6	5
When tasks get harder, I'll continue until I complete them.	6	5	NA	NA	6	NA	5	4	5	3	2	4	5	5	4	5	4	6	5	5
I care more about enjoyment of a task than rewards associated with it.	7	4	NA	NA	5	NA	4	5	5	3	4	5	6	3	4	4	6	4	6	5
I like solving complex problems.	4	3	NA	NA	7	NA	5	4	5	5	5	7	5	5	4	6	5	6	5	5
I enjoy routine work.	5	3	NA	NA	4	NA	5	4	7	1	5	2	4	5	4	6	5	3	5	4
I find it hard to choose where my attention goes. *	5	6	NA	NA	2	NA	3	5	6	6	4	5	4	6	5	2	6	3	6	3
Total	30	22	NA	NA	32	NA	28	21	27	17	19	25	26	20	23	29	24	26	27	25

Of note participant D1 T5, had the highest total score and participant D2T3 had the lowest score. There does not appear to be any discernible pattern between the genders both categories demonstrate high and low autotelic personality scores relative to the remaining samples. The age range category in and of itself is not diverse enough nor large enough to demonstrate any discernible patterns either. While autotelic scores of some participants appear to line up with their propensity to experience flow like was the case with D2 T3 or D5 T4, others like D2 T1 appeared to experience quite a bit of flow on their despite more having one of the lower average scores, plus rain and windy weather conditions during their ride. Some more on this will be described in the combining insights section.

### 5.1.2 Pre-ride survey questions

The survey (both pre-ride and post-ride) had a total of 20 respondents. In addition to the other participants who ran through the entire trial process, this survey was also conducted twice before, pair with two test rides conducted by another Mobycon colleague and myself. These trials were not included in this data set however, as it was deemed this may impact the results in an unintended manner. As can be seen here, the questions were asked both in Dutch and in English, so that participants felt they could answer in whichever language they were most comfortable in.

What is your gender? / Wat is uw geslacht?

20 responses

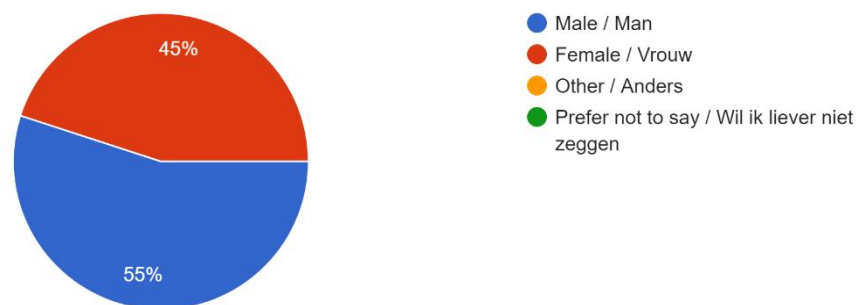


Figure 45. Pre-ride survey gender question. Source: Author

The majority of participants were men, with 11 respondents answering male, and 9 respondents answering female.

What is your age range? / Wat is uw leeftijdsklasse?

20 responses

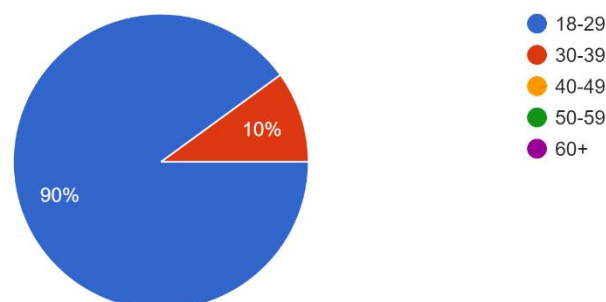


Figure 46. Pre-ride survey age question. Source: Author

The participant age skewed heavily toward the younger age ranges, with 18 respondents selecting the 18-29 range, and only 2 selecting the 30-39 range. None of the older age ranges were represented in these trials, which means the results may not give a holistic insight on planning for recreational cycling for all age groups. This was likely due to the limitations of the participant recruitment procedure, and perhaps that the trials only took place on weekdays, during working hours. Further elaboration is discussed in the limitations section.

How would you rate your overall mood at this moment? / Hoe zou u uw algemene stemming op dit moment beoordelen?

20 responses

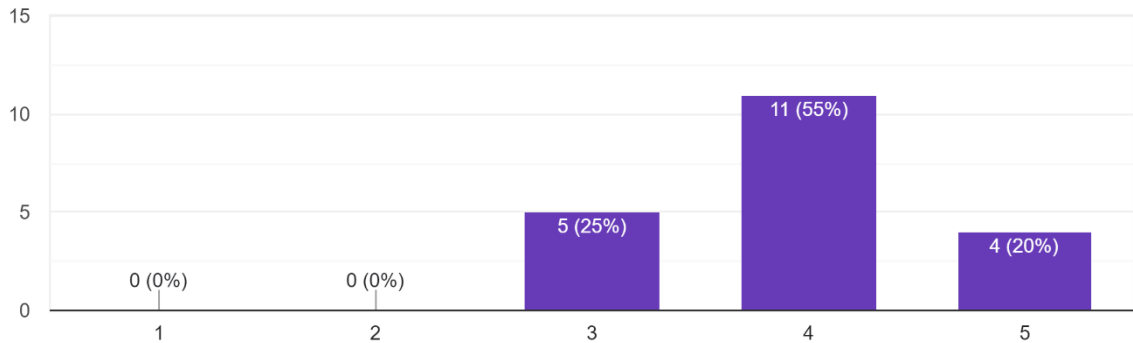


Figure 47. Pre-ride survey mood question. Source: Author

Participants came into the trials mostly with positive moods, with 15 rating their mood as either good (4) or very good (5). The remaining 5 participants listed their mood as neutral (3), with none selecting bad (2) or very bad (1).

How many times do you cycle in a week? / Hoeveel dagen per week fietst u?

20 responses

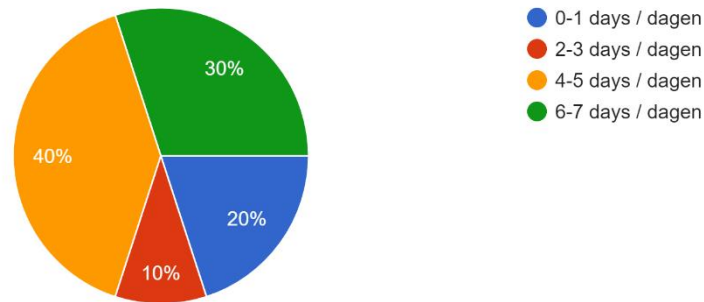


Figure 48. Pre-ride survey question regarding daily cycling frequency. Source: Author

The range was more split with here, but it could be said that 70% (or 14 of the participants) are frequent cyclists either cycling everyday (6 participants) or most days of the week (8 participants).



For what are reason(s) do you cycle each week? / Voor welke doeleinde(n) gebruikt u de fiets elke week?

20 responses

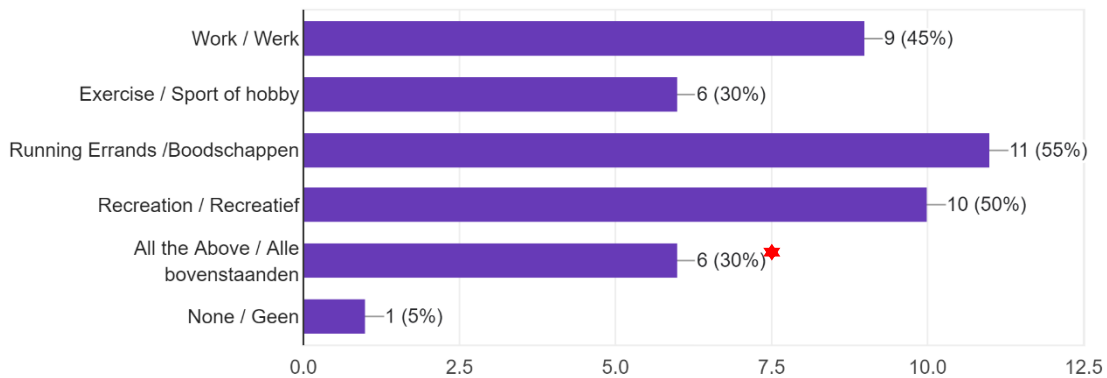


Figure 49. Pre-ride survey question regarding cycling motivations. Source: Author

Of those who cycle each week for various purposes, which appeared to be all one of the participants, the reason for cycling varied and overlapped. What is interesting to highlight is for this thesis is that half of the participants selected recreation as a reason with an additional 4 (20%) selecting all the above.

*\*The reason the chart states 6 (30%) as some participants double selected this option, with some of the other choices, by mistake.*

What would you say is the average distance you cycle daily? / Wat is ongeveer de gemiddelde lengte van een enkele rit die u dagelijks maakt met de fiets?

20 responses

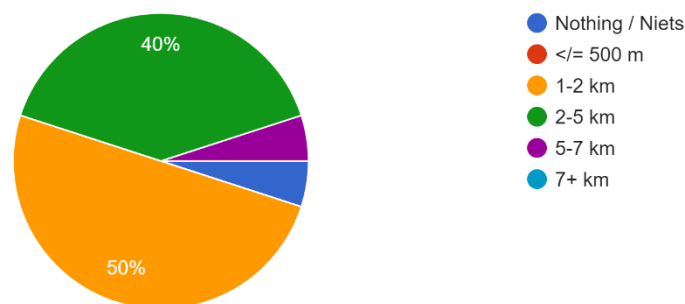


Figure 50. Pre-ride survey question regarding estimated daily average cycling distance. Source: Author

Average daily cycling distance skewed heavily in the middle. With 90% of participants selecting anywhere from 1-5 kilometres.

What would you say the average amount of time that you cycle daily? / Hoelang fietst u gemiddeld per dag?

20 responses

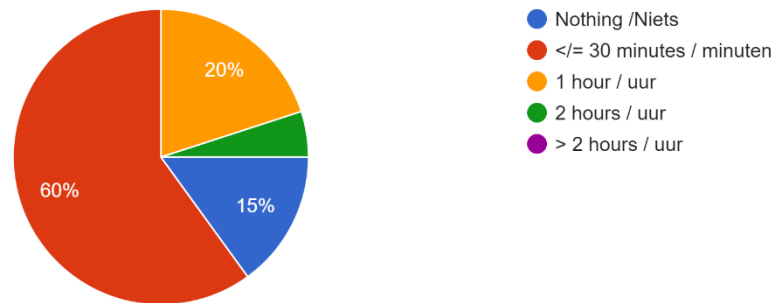


Figure 51. Pre-ride survey question regarding estimated daily average cycling time. Source: Author

A solid majority of 12 respondents (60%) stated that their average time spent cycling daily was 30 minutes or less.

What would you say the average amount of time of a single cycling trip of yours? / Wat is voor u een gemiddelde tijd van een enkele rit met de fiets?

20 responses

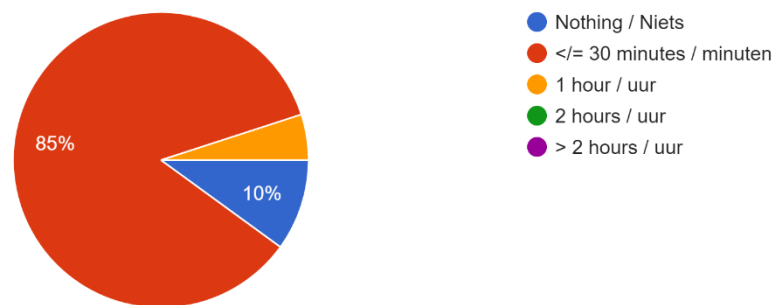


Figure 52. Pre-ride survey question regarding estimated average cycling time of a single trip. Source: Author

When asked about cycling time of a single cycling trip, this swelled majority to 17 respondents (85%) stating that it was 30 minutes or less. Only one participant stated that their average cycling trip time was around an hour.

What type of area do you prefer to cycle in? / In welke omgeving fietst u het liefst?

20 responses

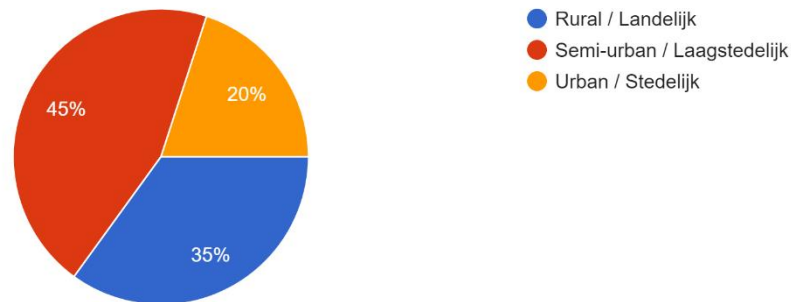


Figure 53 . Pre-ride survey question pertaining to cycling landscape preferences. Source: Author

There was a split in the area/landscape preferences of which participants preferred to cycle in. Up to 7 respondents stated that a rural area was their preferred, 9 preferred a semi-urban/suburban area, and 4 preferred to cycle in urban areas.

Participants were asked to why they held said preference. Those who preferred a rural setting tend to respond that factors such as low-traffic, quiet, low-stress, and being surrounded by nature contribute to their preferences.

Those who preferred a semi-urban environment tended to highlight the surroundings as well, but they also stressed the importance of having a balance of vibrancy yet it still not being too busy as major factors contributing to their choice. This idea of the semi-urban being the ‘best of both worlds’ was a common trend among these participants. As one answer highlighted by D1 T2 who is a male from the 18-29 category, “[There is] less traffic than in urban areas but still better infrastructure for bikes than in rural [areas].” Such statements further contribute to the idea that balance was an important factor with these participants.

With those whose preferences was to cycle in urban environments, the idea that the city was a more lively, interesting place, seemed to resonate. As participant D5 T2, also a male from the 18-29 age range category stated, “I like the hustle and bustle,” suggesting that a stimulating environment, where a lot is happening, such as urban area, is appealing to this individual. Another participant highlighted that they lived in an urban area, and hence cycled around to get from place to place. So perhaps, the notion of familiarity helps to contribute to their preferences. The same may be true from some of the other participants as well.

With those whose preferences was to cycle in urban environments, the idea the city was a more lively, interesting place, seemed to resonate. As one participant stated, “I like the hustle and bustle,” suggesting that a stimulating environment, where a lot is happening, such as urban area, is appealing to this individual. Another participant highlighted that they lived in an urban area, and hence cycled around to get from place to place. So perhaps, the notion of familiarity helps to contribute to their preferences. The same may be true from some of the other participants as well.

## 5.2 Trial Results Quantitative

This section will overview the EDA sensor and video data collected. A holistic approach to the data analysis shall be summed up here, analysing the trends, and patterns present between participants, whether through the EDA data, facial expressions, or some other combination of factors.

### 5.2.1 EDA data analysis

The chart(s) below presents the EDA data from 12 of the 20 participant trials. The remaining trials were left out as their data, either had 'clipping events' (errors), or the Emotibit device stopped recording during the ride, or in some cases even before the ride began. This was particularly the case during the first day of trials, where the Emotibit was employed with the dry electrodes that came with the device. So only the last trial from that day is present in the graph below (D1 T7). Data consistency from the Emotibit sensor proved to be much greater once the wet-electrode method was employed. Hence the data from the second of day of trials, onwards tended to have far less issues in terms of clipping events or other technicalities.

It should be noted that this could have been improved further as there was not enough wet electrodes for the remaining trials and ordering more to arrive in time proved to be a challenge. Thereby improvisation was needed. So, for some of trials, wet electrodes were reused after carefully being sealed in their packaging and refrigerated for some time before use. This improvised method appeared to work well; most trials conducted in this manner producing a similar range of result to those conducted with fresh wet electrodes. Nonetheless, this could very well have had an impact on the results, and it would not be advised for this to be repeated.

The naming convention used on for chart(s) below is as follows: D# T# in which D# denotes the trial day and T# denotes the trial number. So D4 T2 stands for Day 4 Trial 2.

# EDA Comparison Chart

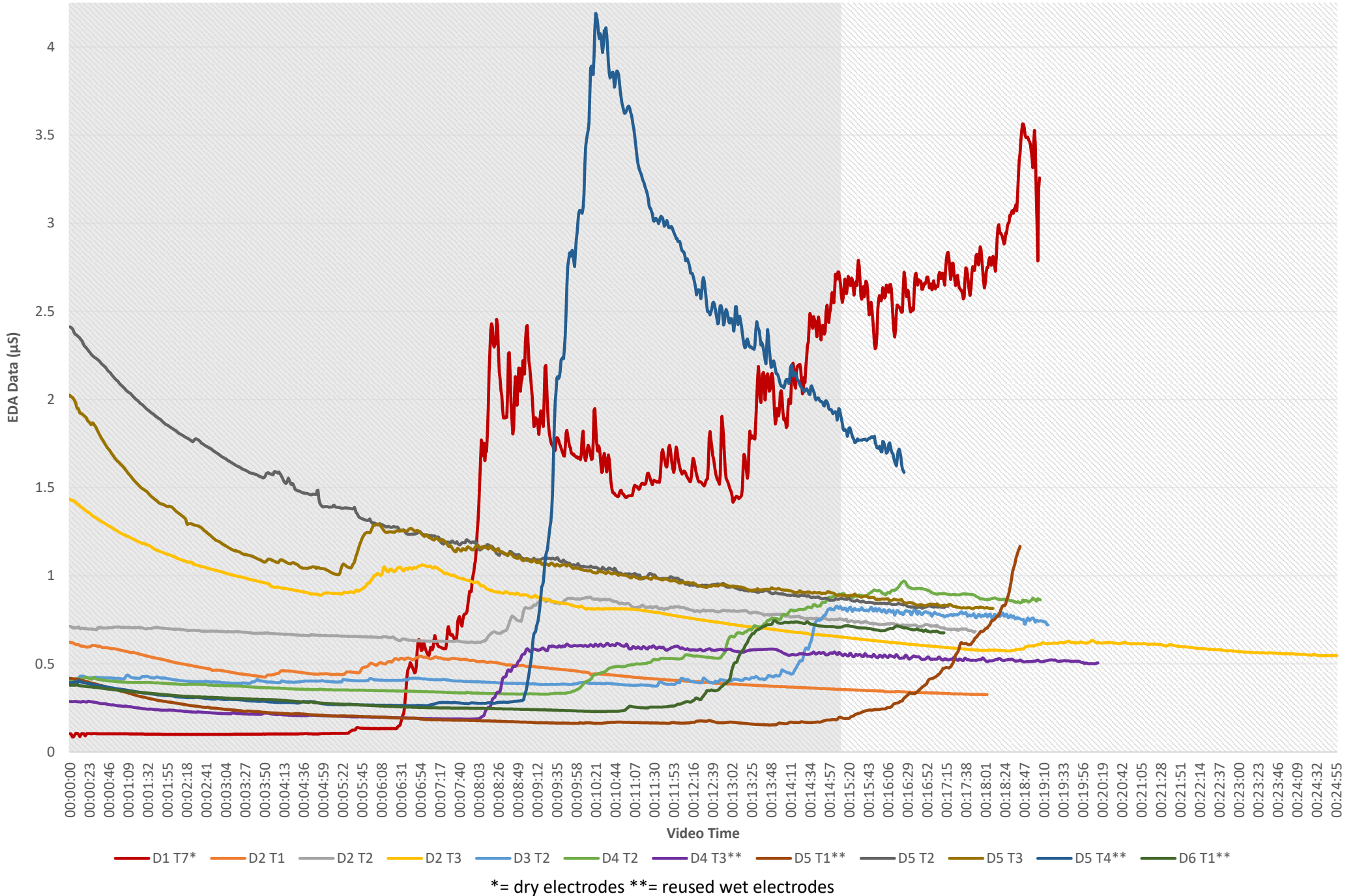


Figure 54. EDA charts from all trials that produced usable data. Source: Author

Here we have a culmination of all the results from the 12 trials that produced data out without any clipping events, for the entirety of the given cycling ride. As can be seen, high divergence exists within the EDA data of individual participants. But when examined closer, some general trend lines can be observed. For example, most trials demonstrate at least one major trendline of an upward trajectory somewhere within the trial, suggesting some sort of state of arousal or stress, was shared among participants. This data was cross referenced with data from the camera and statements made by participants during the interactive interviews, some of the potential causes of these data spikes became apart.

A common correlation found, was that the EDA data would often beginning to spike in an upward trajectory, around when participants began to cycle up onto the dike. This was one of the only elements of topography on the course, where participants had to cycle uphill, and thus could be the cause of additional sweat secretion, and hence a source of arousal for many participants. Another common cause of EDA spikes, both small and large, but nonetheless observable in the graph datasets, was some sort of interaction between participants and cars. Most typically observed was when a car or other large vehicle, overtook the given participant. Less common but also observed was when participants had to stop suddenly due to a car or other motorized vehicle. In any case, these correlated to an observable spike in the EDA data, thus helping to confirm a moment of stress or arousal by cross-referencing this quantitative data with qualitative data shared by participants.

# EDA Comparison Chart Divergent Trials

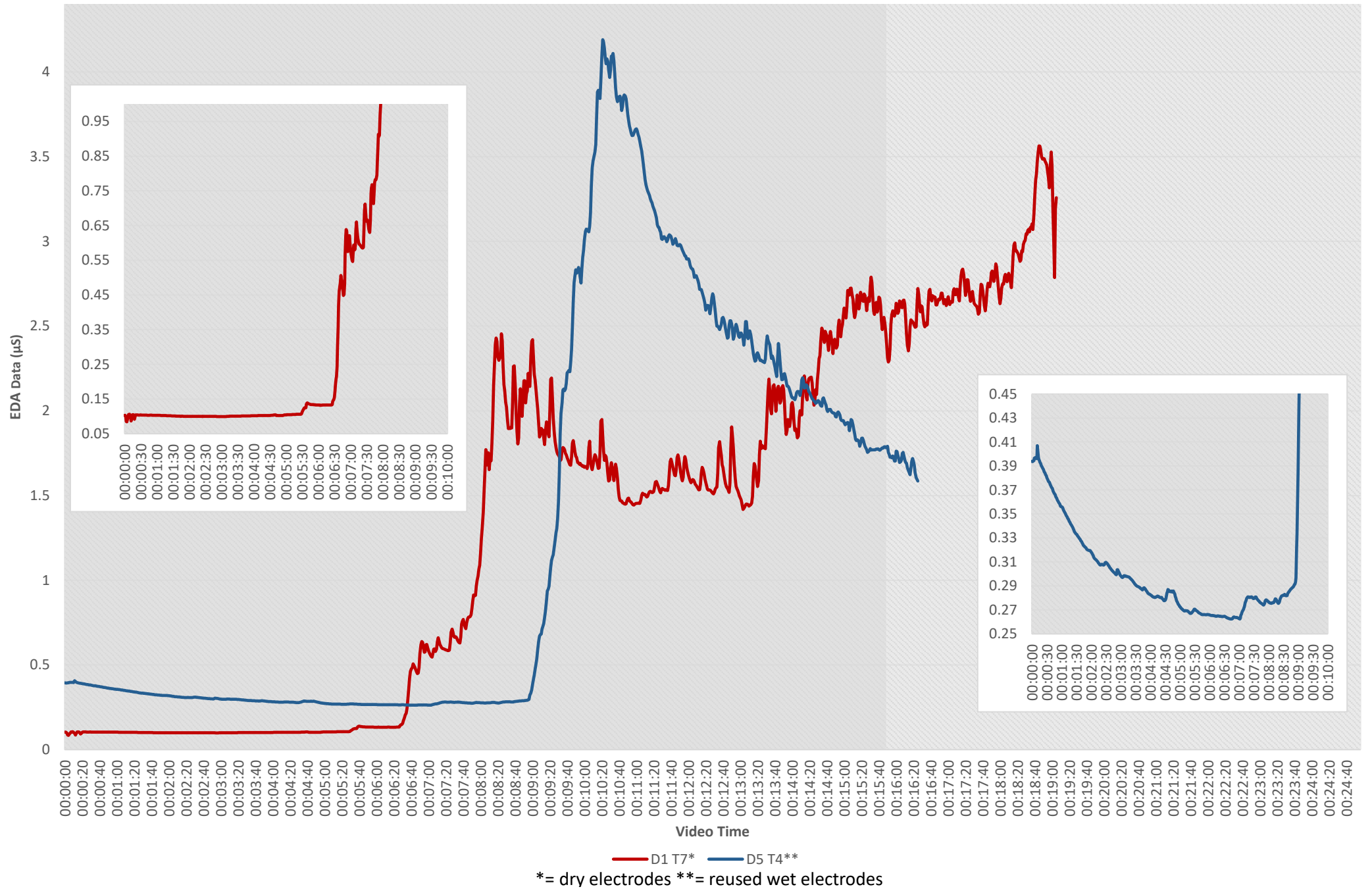


Figure 55. EDA Chart of Divergent/outlier trial data. Source; Author

Upon further cross-examination with the other data sources, it is the beginning of the major uptick present in D1 T7 appears to correlate with the participant cycling over a road bump at (). At approximately 07:38, a car goes by the participant, followed quickly by the participant reaching to take out their phone, with their left hand (where the sensor is present) hence correlating with the second and most dramatic spike in the data. Not enough information is present to definitively say if was the participant's movements, their emotions (wondering if they were still going the right way, based on their actions present in video, as well as statements made during their interview), a combination of that played casual factors in the major uptick of data seen here. From this point forward, sharp rises and peaks continue for the duration of the trial, more dramatic than any almost any other of the trials run. This may in part correlate with the windy conditions experienced by the participant, but it also may in part be due to the use of the dry electrodes, that thus seem to produce a higher data variance than those trials run with wet electrodes.

The other trial with a high degree of data variance was D5 T4. By far, the largest spike in the data with this trial begins at around 08:56, as the participants begins cycling up the dike. The EDA reaches its peak at over  $4.1 \mu S$  when the participant begins to approach the end of the dike, heading downhill, onto the beginning of Section 4. What may have made this notable compared to others, is that it was particularly warm (around  $20^{\circ} C$ ), hence the participant was wearing short sleeves, potentially allowing the Emotibit device to be exposed and more influenced by other elemental forces than when it was under a sleeve. This participant also highlighted the fact they felt quite aware that they were on a trial notably due to the presence of the camera recording them. At the same time, they also had one of the higher autotelic personality scores of 27, suggesting that under usual conditions, their propensity to enter flow was quite high. Furthermore, this was one of the trials where a wet electrode was reused, to help manage the limited stock, so there is potential that said factor had an influence on the data validity of this trial.

Nonetheless, both of these trials seem interesting to highlight, to demonstrate the degree of data variance present, and how slight alterations, intentional or otherwise, can have an impact on sensor results.



Continue to next page.

# EDA Day 2 Comparison Chart

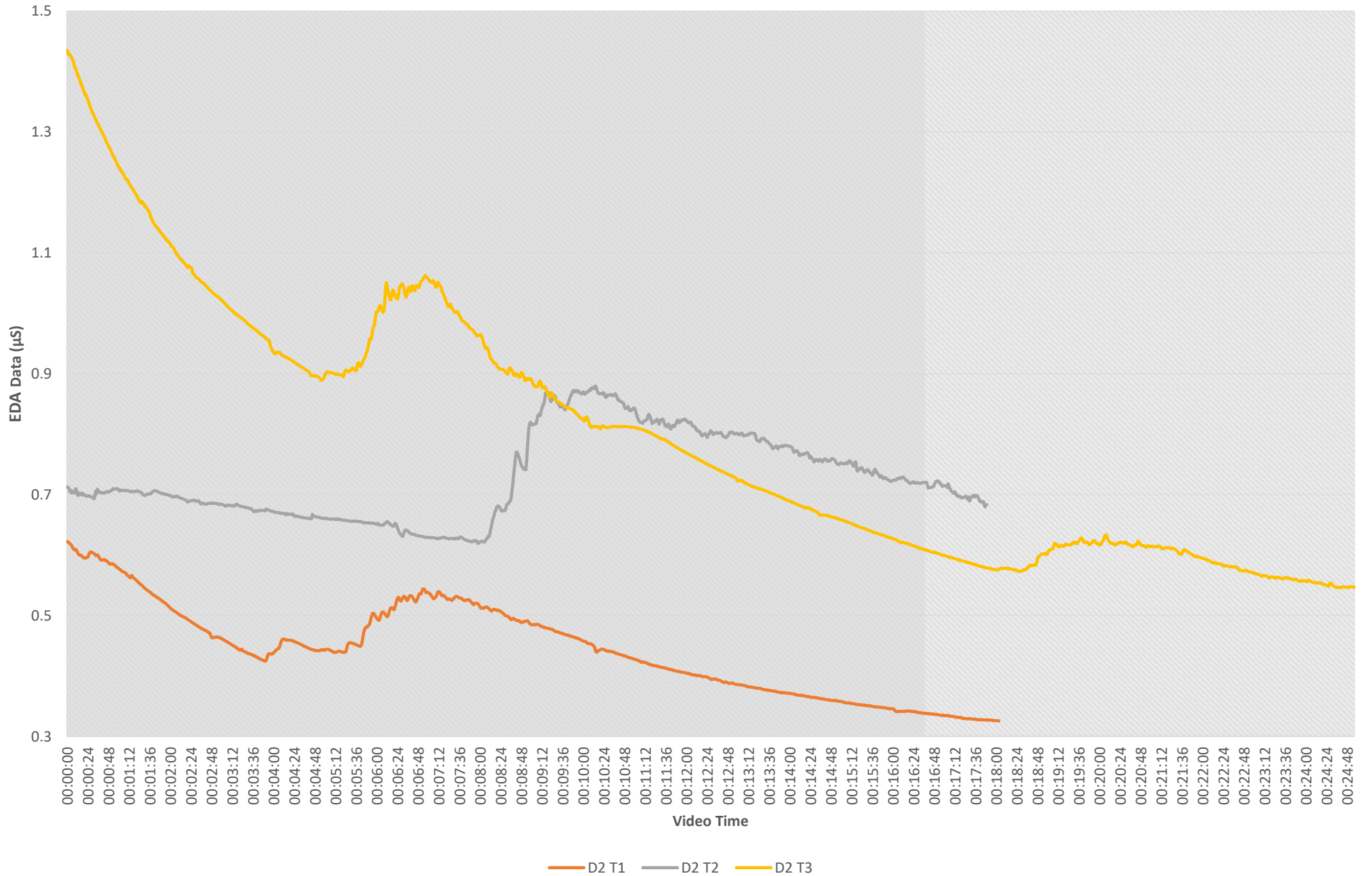


Figure 56. EDA comparison chart of Day 2 participants. Source: Author

The data from the Day 2 trials appeared particularly interesting to pull out for further examination. As can be seen in this more zoomed in graph above, all three of these trials share a very similar EDA trendline. While the data range as measured in microsiemens ( $\mu S$ ) varied from participant to participant, each trial began with the EDA trendline moving in a downward trajectory. Then at some point in the middle of the ride, the data began to spike in upward trajectory, before beginning to fall again in a general downward trajectory.

The similarity in trend line may have something to do with the trials taking place on the same day in roughly similar conditions. This day was relatively windy and rainy throughout. Yet when examined closer, the source of the respective stimuli in each trial appeared to be different from participant to participant. For D2 T1 the major upticks correlate with moments present in the video footage where the participant, appears to be reconfirming that they are on the right route, as can be seen by them looking at their phone, and turning their head back and forth, looking for the arrow markings, to ensure they are on the right path.

For D2 T2, a major uptick in the EDA data appears to begin, at the transition zone between section 2 and 3, as the participant becomes more exposed to the wind. Further uptick correlation occurs as the participant cycles on the dike. The untick continues through a good portion of this section before it begins to fall back down, albeit with a very sporadic fashion. It may be worth noting that this participant described the dike as the best part of the ride, yet also as having the most 'stress', due to the windy conditions felt there.

In D2 T3, two data upticks are present since the participant stopped for some time, in hopes that the weather would calm down a bit. Both upticks correspond to times when the participant begins to cycle against the headwinds. In the corresponding video data, the participant can be seen at 18:52 covering their forehead, due to the wind and rain making it particularly cold. This corresponds within the second EDA uptick present within this trial.

### 5.2.2 Camera data

As was stated in the methods section, the camera allowed us to capture data on participants' facial expressions, as well as being used as tool for memory recall in the post-ride interactive interviews. This subsection will focus on the trends observed in the former point.

Nearly all participants, appear to have moments (if not the entirety of the ride) where their eyes and head appear to wander, looking back and forth to take in different aspects of the scenery around them. This can be mostly strongly observed, through Sections 2 and 3. It occurs somewhat often in Section 4, and least often in Section 1, though still noticeable at times. The 'flow face' as described in the methods section, with a long deep stare, often paired with one's mouth being slightly open, was observable on some, but not all participants.

Facial expressions of unpleasantness were also occasionally observed. This was perhaps most prominent in with participant D2 T3, was observed with their eyes squinting, forehead creasing, mouth open appearing to breathe heavily as they are cycling against the wind and rain. They proceeded to place their hand on their forehead shielding it from these elements as an unpleasant cold sensation was felt there, as they later confirmed in their interactive interview. Other facial expressions or behavioural observations that could be interpreted negatively were when participants would turn their heads frantically in attempts to look out for the next turn. One participant, D5 T2 even ended up missing the turn initially within section 2, yet quickly realizing their mistake, and turn swiftly back onto the course. Such actions represent some underlying stress, anxiety, or worry caused by a sense of uncertainty as to when the next turn in course would be.

### 5.3 Post-Ride Survey Overview

After participants came back from the ride, the next series of questions were asked to get a sense of the change in mood, enjoyment of ride, likes and dislikes with the route, as well as to get a sense of if they may have been in Flow during the ride, or part of it.

How would you rate your overall mood now, after the ride? / Hoe zou u uw stemming nu beoordelen, na de fietsrit?

20 responses

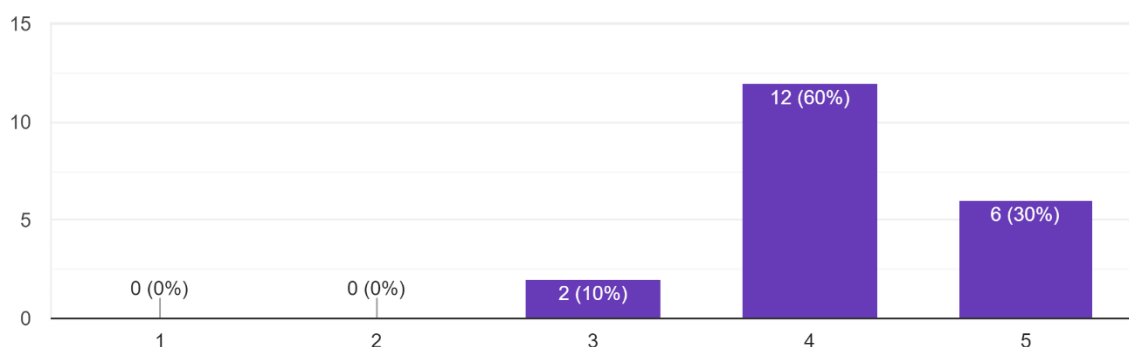


Figure 57. Post-ride question on mood. Source: Author

If compared to the similar pre-ride question, participants' mood as a whole appears to have ticked upwards with a higher percentage (from 55% to 60% and 20% to 30% respectively) saying their mood was good (4) or very good (5).

Did you enjoy the ride? / Vond je de rit leuk?

20 responses

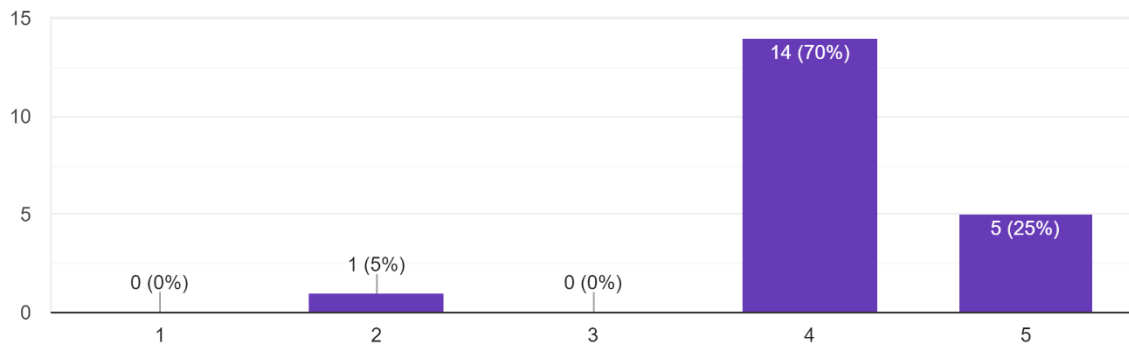


Figure 58. Post-ride question on sense of enjoyment. Source: Author

All but one participant appeared to have enjoyed the recreation cycle ride entirely (25%) or mostly (70%). This was despite the weather being rather poor on several of the trial days as well.

Were any parts of the course more enjoyable? / Waren er delen van de route leuker?

20 responses

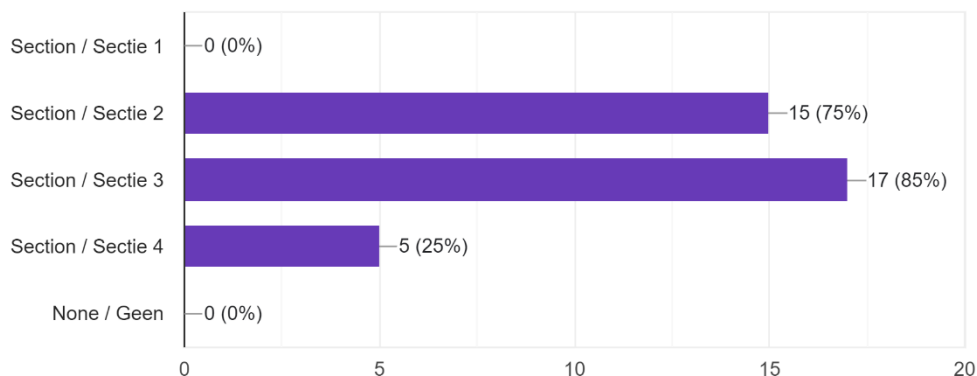


Figure 59. Post-ride question on most enjoyable course sections. Source: Author

Participants appeared strongly in agreement the sections 2 & 3, or least aspects of them, were the most enjoyable parts of the course. Participants were also asked why. For Section 2 participants highlighted seemed to highlight the variety of things to see such as the nice houses/ neighbourhood, gardens and the large trees that covered the last 2/3rds of this section. For section 3 participants highlighted the greenery, nature, the sight various animals, and the views, particularly of the IJssel river. Those who specifically mentioned section 4, seem to like it in instances when the wind was pushing them forward, and from a goal-oriented perspective of that knew they were getting closer to

finishing the ride. Common among all of these sections, participants enjoyed that there was little to motorized traffic to share the road with.

Were any parts of the course less enjoyable? / Waren er delen van de route minder leuk?

20 responses

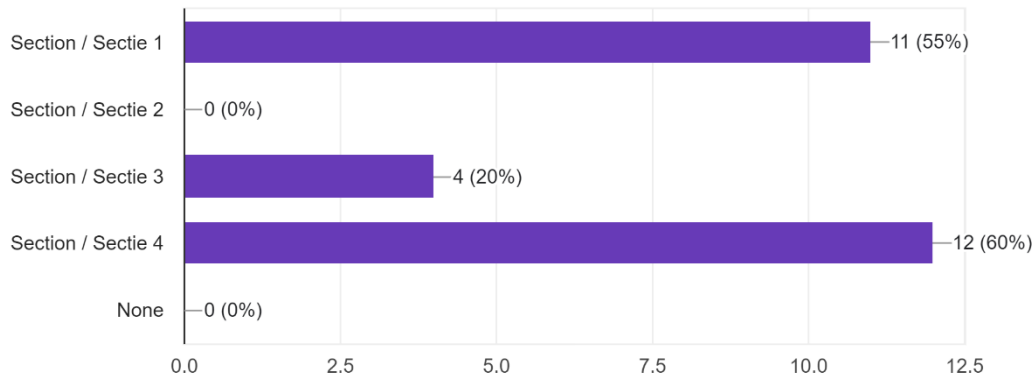


Figure 60. Post-ride question on least enjoyable course section. Source: Author

Of those who disliked section 1 the primary reason seemed to be the stress or business of the environment. In this section participants, had to share the road with more cars, as the infrastructure provided here consisted only of painted bicycle lanes. Thus some participants felt, unsafe. Others also felt that the type of urban environment present in the surroundings here was simple uninteresting. With those who disliked section 3, their issues steamed primarily from the weather. When it was rainy or windy in this section, participants could really feel it, as on most of this section, and especially on the dike, the environment was more open. Thus leaving one exposed to the elements. For Section 4 while there was some irritation with the weather, particularly if the wind was coming against the participants, the most common complaint about this section can be summed up in one word: boring. Section 4 is a long straight section along the rail tracks, comprising of little to look. One on side you the overhead rail lines and a long green wall. On the other side a wall of trees, blocks the view agricultural fields, followed by some small commercial buildings and a large grey parking garage on the that likely contribute to the sense of repetition and mundaneness experienced by many participants.

If the experience (or aspects of it) were enjoyable, why? / Als de ervaring (of delen ervan) leuk waren, waarom?

20 responses

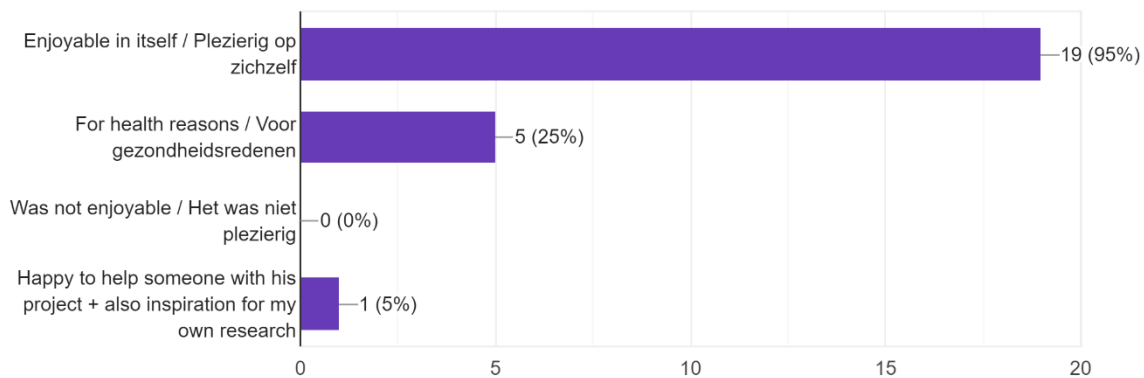


Figure 61. Post-ride question on reason for enjoyment. Source: Author

It is interesting to note that all but one of the participants, felt that the experience was enjoyable in itself. Perhaps this is due to the nature of this trial being focused on recreational cycle rides, or perhaps has to do with the limitations of the participant sample (whether demographically, or simply the sample size). This aspect of would be interesting to note the changes that occur if similar trials are run in different contexts, or with more participants.

Throughout this ride how often did you feel a sense of complete concentration on the task? / Gedurende de rit, hoe vaak had je een gevoel van volledige concentratie op de taak?

20 responses

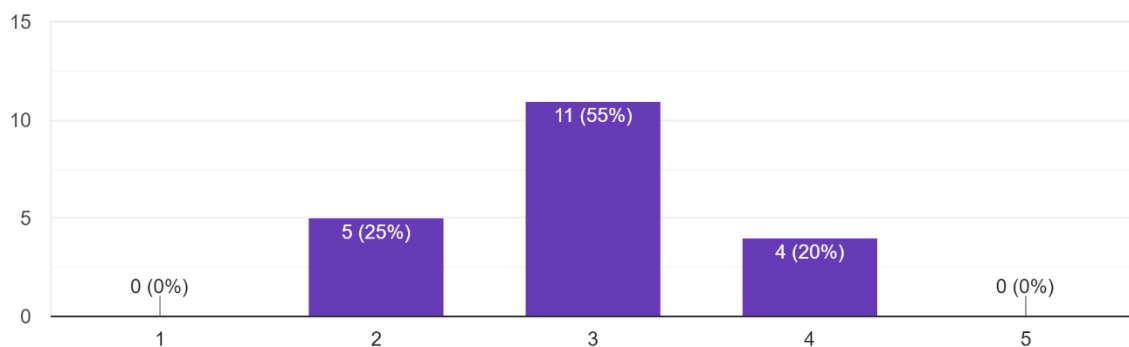


Figure 62. Post-ride question on concentration. Source: Author

When it came to this aspect comprising the conventional definition of 'flow' participants tended to score more in the middle ranges. This suggests that focus was more sporadic, and perhaps concentrated in certain parts of the course over others, where participants' minds thus tended to wander instead. Further details on this were asked during the interactive interviews. More details can be found in the participant interviews section.

How often did you feel a change in your sense of time (speeding up/slowing down)? / Hoe vaak voelde u een verandering in uw tijdsbesef (versnellen/vertragen)?

20 responses

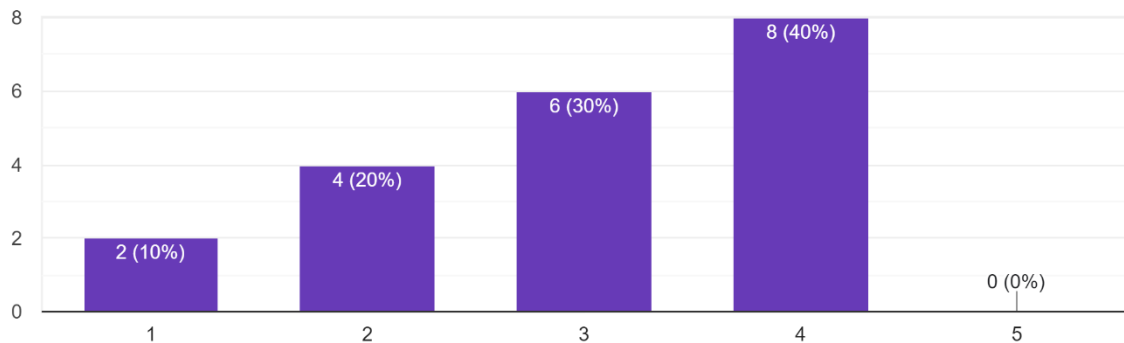


Figure 63. Post-ride question on sense of time. Source: Author

Change in the sense of time was experienced, at least partially, by 90% of participants. Yet not a single participant felt their time perception was altered for the entirety of the course, suggesting that it takes some time for changes in temporal perception to occur, if they will at all.

If you felt a change in your sense of time, how would you describe it?

19 responses

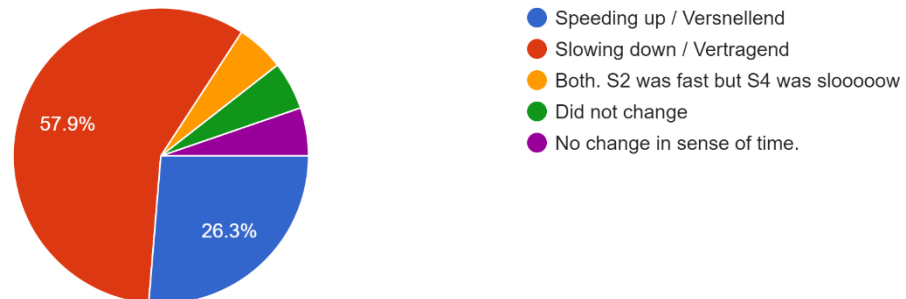


Figure 64. Post-ride question on type of time dilation. Source: Author

Of those participants who did experience, a change in their temporal perception, most experienced it as a slowing down in time, yet a little over a quarter of experienced it a speeding up of time. Just one participant stated they experienced both states. However, in the way that the question was phrased to participants, only the options of 'speeding up', 'slowing down' or 'other' were present. Perhaps more would have chosen the 'both' option if were to select, as the details describe by various participants during the interactive interviews painted a more complex picture. More details can be found in the participant interviews section.



Did this experience feel rewarding in itself? / Voelde deze ervaring belonend?

20 responses

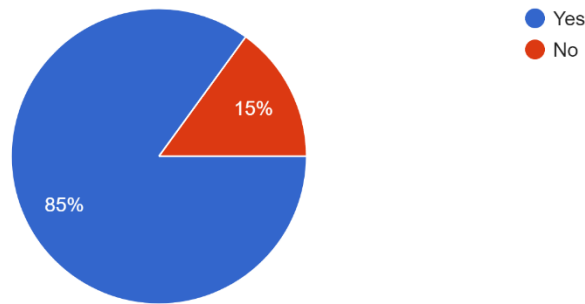


Figure 65. Post-ride question on reward motivation. Source: Author

Compared to the sense of enjoyment question, less participants found the cycling ride to be intrinsically rewarding. Yet still, a sizable majority of 85% found this to be the case.

How often did you feel a sense of effortlessness or at ease on the ride? / Hoe vaak voelde u zich moeiteloos of op uw gemak tijdens de rit?

20 responses

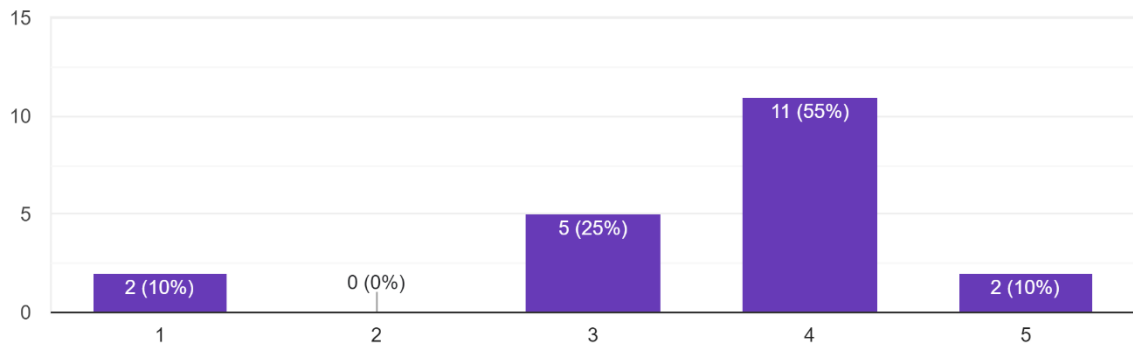


Figure 66. Post-ride question on sense of effortlessness. Source: Author

Answers to this question varied widely. This was cross-referenced participants' pre-ride responses to their level of cycling experience. Interestingly there seemed to little correlation between these factors, both the respondents who stated never (1) and always (5) all reporting either a high weekly frequency of cycling and/or high average daily trip distance. This may suggest either that the term 'effortlessness' was interpreted differently by various participants, or that other factors played an outsized role, such as the weather on a given cycle trip.

How often did you feel adequately challenged? / Hoe vaak voelde u zich voldoende uitgedaagd?

20 responses

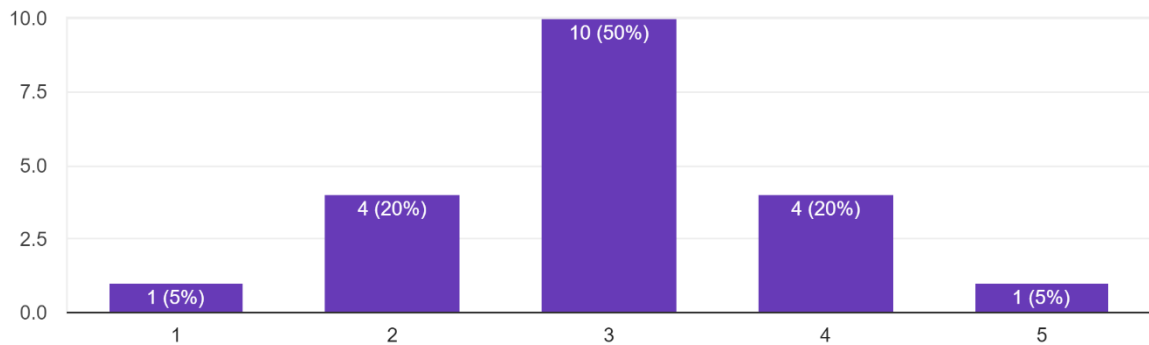


Figure 67. Post-ride question on sense of challenge. Source: Author

Answers to this question had a very even spread, averaging out to most participants felt challenged at least, sometimes (3). When individuals' answers were further cross referenced, it would appear to support the notion that some participants interpreted this or the above question differently than others. For example, one of the participants who stated to the above question they always (5) felt a sense of effortlessness, also answered that they always (5) felt adequately challenged on this ride as well. This may suggest that said participant felt this ride, or cycling in general is a relaxing activity, hence putting them at ease, yet also a stimulating activity, hence making them feel adequately challenged. More on this will be explored in the participant interviews section.

Did you ever sense a feeling of merger between your actions and awareness during this ride? / Heb je een gevoel van samengaan van je acties en je bewustzijn gehad tijdens deze rit?

20 responses

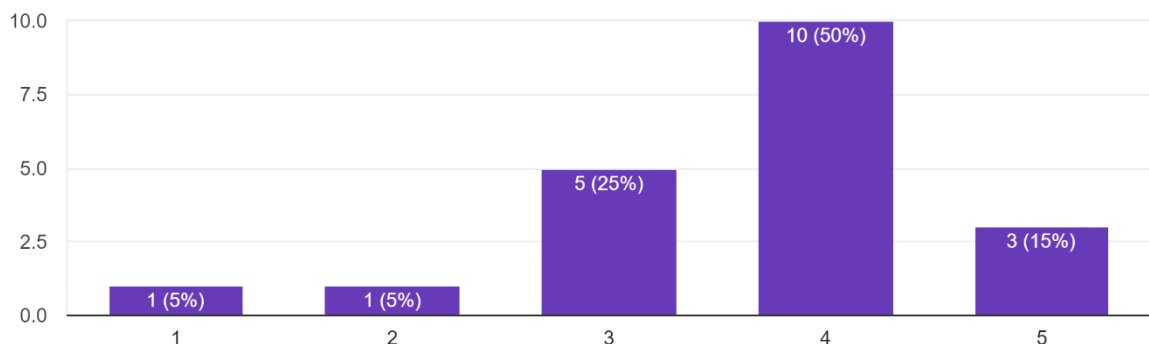


Figure 68. Post-ride question on awareness/action relations. Source: Author

Based these responses, most participants (65%) appeared to be attuned to the bike and the fact that they were cycling most of (4) or all of (5) the time.

Did you ever feel a sense of loss of control? / Heeft u tijdens de rit het gevoel van controleverlies gehad?

20 responses

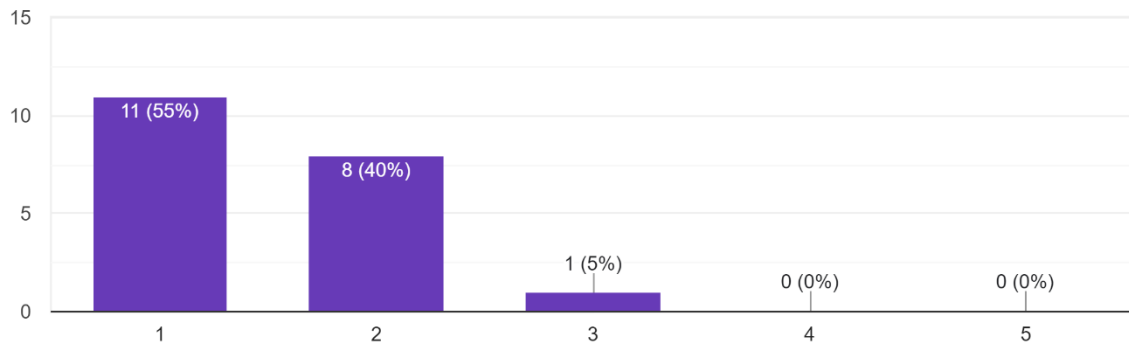


Figure 69. Post-ride question on sense of control. Source: Author

Overall participants appear to rarely, if ever experience a loss of control, with no participant choosing to the options of most (4) or all of (5) the time.

How often did you experience a sense of total focus on the task? / Hoe vaak ervoer je een gevoel van totale focus op de taak?

20 responses

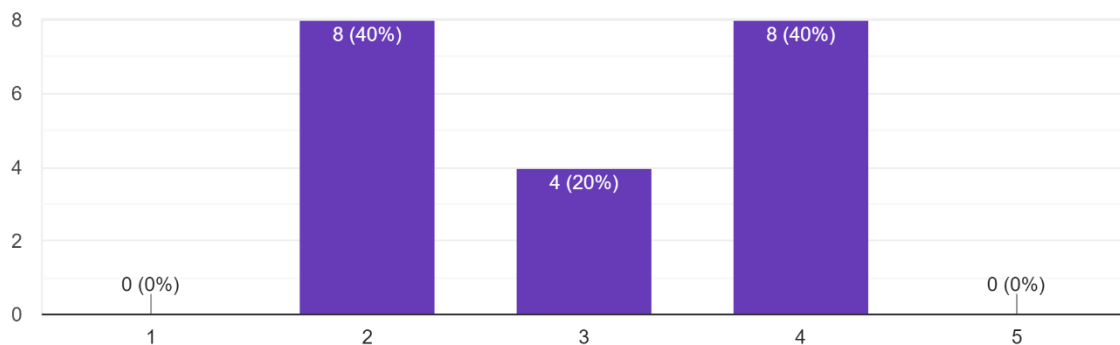


Figure 70. Post-ride sense of focus question. Source: Author

Participants answered tended to vary here, yet no participants answered that they never (1) felt this total focus nor always (5) did. It is interesting to compare these answers to the similar question about 'complete concentration', as this graph appears almost like the inverse of that graph. Here participants were more divided as to if they mostly (4) felt a sense of total focus or rarely (2) did so. Whereas with the "complete concentration" question, 55% felt that they sometimes (3) experienced this.

Focus is about intention, whereas concentration is about what you do with that intention. Focus implies prioritization of goals, whereas concentration is about directing one's energy toward specific tasks. One can focus on a task without concentrating and vice versa (Wooll, 2022). In this context,

participants may be focused on cycling the route, but other dilemmas like school or work projects could be drawing their concentration away from the task at hand.

Assuming participants interpreted these differences in similar manner, that data seems to suggest that overall participants were more consistently concentrated, yet more individually divided on their degree of focus. The relevance is that this may have implications on their ability to achieve flow.

Did the weather affect your results? / Had het weer invloed op uw resultaten?  
20 responses

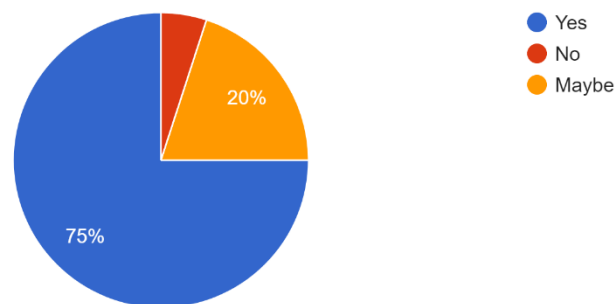


Figure 71. Post-ride question on impact of the weather. Source: Author

Most participants agree with the notion that the weather had an impact on their results. This should be taken into account, especially since most (check this) days these trials were run there were at least periods of rainy and/or windy conditions.

## 5.4 Interviews

Both the participant and expert interviews helped to shed some insights into some of the potential connections to be made between Flow Theory, placemaking, and urban vitality within the recreational cycling context. There were several key points of overlap shared by both the trial participants and expert interviewees regarding environmental aspects may help contribute to eliciting more positive experiences when cycling. Such insights hopefully can be used to help improve the planning and development of recreational cycle routes.

### 5.4.1 Participant Interviews

Two participants, D1 T1 and D3 T1 both ended up getting lost, thus effecting their ability to adequately judge the route quality overall. Participant D2 T3 generally felt that the ride was unpleasant due to the strong head winds and rain. In fact, their trial took longer than others as they stopped for some time in hopes that the rain would lessen in intensity, before continuing with the rest of the course. The remaining participants found the experience enjoyable, and the course, or least aspects of it enjoyable.

As was also demonstrated in the survey results, participants overwhelming preferred sections 2 and 3, with the preference of one section, or sub-section within these sections, coming more down to preferred aspects, like natural or architectural features, variety, or vast open scenery. Virtually every

participant enjoyed section 2 or aspects of it, even if they preferred sections 3. Most notably, the subsections where the road was covered by canopy (sections 2b & 2c), as participants really enjoyed the shade, ambiance, and sense of protection this brought. As participant D6 T1 described, *“The row of trees was very pleasant as they accentuated the feeling of going forward.”* Furthermore, the vibrancy of this section was highlighted with many participants commenting on how much there was to look at throughout this section, with many mentioning the nice houses, gardens, and slow transition to countryside along this section.

The transition from section 2b to section 3a was also a point which several participants made sure to highlight. Participant D3 T2 outright stated that this was the part of the course they most likely felt in flow. At least 8 other participants (D1 T2, D4 T3, D5 T2, D4 T1, D4 T3, D5 T2, D5 T4, and D6 T1) indicated that they felt either most in the moment or began to feel in the moment/zone during this part of the ride.

At least 9 participants (D1 T2, D1 T5, D2 T1, D2 T2, D4 T2, D4 T2, D5 T3, D5 T4, D6 T1) as well felt that they were in the moment either during or through section 3. The preference for section 3, for some was far more weather dependent, due to the open nature of this section where one is more exposed to the elements. This was especially true on the dike (section 3b). Participants who demonstrated a strong preference for this section highlighted the views of the river, bridge, and being surrounded by nature. When the weather was nice, aspects of vitality here were also highlighted, as expressed by participant D5 T4, *“A lot of people [were] outside, running, cycling, ... walking their dogs. There was quite a lot going on with people enjoy the nice weather and the nice nature there.”* However, those who did not have so favourable views of this section highlighted their exposure to strong winds, or rain, making it more difficult to cycle here, and least enjoyable overall.

None of the participants, even those who said they generally preferred to cycle in urban areas, favoured section 1. Participants either found this section a bit stressful, having to share the road with cars, characterised the section as boring, ugly, or a combination of these. Participant D1 T3, who stated a strong preference for urban areas, suggested that it would have been interesting if part of the route would have gone into the city centre (due to the additional time and route complications, this was ultimately decided against) as it may have presented a different side to urban environment, one where there was more things to look, and more variations in the cycling infrastructure. *“[The urban context] is interesting and pretty. There’re different buildings, different people. There’s a level of stress but I also like that, it’s like fun.”* There was more the overall urban context that allows this participant to reach that balance of challenge and skill (flow), that she did not feel like she was quite able to experience here. Participant D1 T4 also remarked this as well, feeling that more and different city environments would have been interesting to include, as even in the Netherlands, there can be quite a difference in the cycling experience, in this context alone, citing Rotterdam and Utrecht as contrasting examples.

Some participants enjoyed section 4, like participant D1 T6 who enjoyed the infrastructure (cycling highway) there. Whereas others did not like this aspect for example participant D5 T1, who did not like the concrete ridge that separated the 2 cycling directions. Others like D2 T2 and D2 T3 enjoyed this section contextually and in a goal-oriented sense, citing that wind was on their backs and that they knew that course was almost over. However, most common description of this section was that it was boring. Several elaborated that this section was long, straight, and ugly. And that there was not much to look at since on one side the route simply followed the rail line, and on the other were some trees, fields, and buildings but they were not organized or arranged in a manner that was particularly interesting or stimulating. They appeared more as monotonous blobs of green and grey to participants.

In the survey, most participants mentioned that their sense of time overall was either slower or faster, more nuanced responses were given during these interviews. This was summed up well by participants D1 T4 who stated, *“It sort of felt like to some extent if you are enjoying the ride, the time flies,”* comparing his perceived experience of earlier sections in relation to section 4 that felt long.

Other things of note were that road design, preferences were not that strong for many participants when it came to cycling in the recreational context. Some preferred a smoother surface texture, but others like participant D2 T3 stated that they would often be fine with a dirt trail in this case. What was more important overall was a lack of interaction with motor vehicles. This was almost always highlighted as a positive for participants, both reducing potential stress, and allowing one to be more immersed in the experience. Another big factor that participants felt was important to greater immersion in recreational cycling routes was variety. Participant D2 T3 highlighted how they found nature reserves to be the most interesting recreational cycling environment due to the variation in natural landscape features, such as forests, to meadows, etc. Participant D5 T4 highlighted how change and variety brought about in part by the curviness of a route was something that really added to the immersion of the experience. When asked about what makes a route repeatable, she alluded to a route near her hometown, that *“makes me feel like I’m on holiday.”* She went on to say that this repeatability quality was present on this route on the dike due to its views and vibrancy and in transition from section 2 to 3 due to the contrast of big to small trees. Participant D6 T1, however highlight that while variation and diversity were important, quality is still more important. For instance, a cycle path that run through a diverse array of industrial zones would still not necessary be a pleasant experience, if there aren’t other factors like nice scenery to bolster it.

Finally, while some participants may have experienced flow on this course, the more common state of mind that resonated with participants was relaxation. Weather for the course overall, or for the parts they enjoyed the most this was the most common term used to describe the positive qualities of this course or experience.

#### 5.4.2 Expert Interviews

With Expert 1 it was discussed how the reasons that people choose to cycle are ‘clearly not mono factorial’. A place like Southern California, may have the optimum weather for cycling, but this factor alone is clearly not strong enough to offset remaining factors, like poor disconnected infrastructure, safety, urban sprawl, etc.

##### 5.4.2.1 Flow in the planning/ mobility context

When asked about this Expert 1 went on to state, *“Flow is about optimum stimulation and engagement in what we are doing. If we have too much [mental processing load] then it caused stress... on the other extreme is boredom. So not having enough stimulus. Flow is this optimum level of stimulus and processing your surroundings.”* He goes on to relate this to the experience as driving, being that it is a more common human experience than cycling. *“If you’re going down the highway and there’s zero stress. Like a straight flat highway in like the American desert, it’s actually very easy to fall asleep... Especially when it’s at night and there is not much traffic around.... This is clearly not a state of flow if you are nodding off due to a lack of engagement. If you go into urban driving like a dense city environment...gridlock traffic.... You want to get going but people all around you are stopping you from moving. There’s a sense of frustration... [In] cycling you rarely have a situation where other people are*

*preventing you from where you need to go... because you're very nimble."* He goes on to relate this back to some bicycle highways, they are familiar with the outskirts of Amsterdam that are long and straight, with parts along a railroad (like section 4) that makes them feel bored and "completely zone out". Consequently, when riding here they would often listen to music. *"I find when I reach the Amsterdam outskirts and it really starts to be urban... that the music is almost too much because I need the extra sense of being able to hear around me. Especially on these shared streets... In principle, you have priority and can ride in the middle of the street. But if there's an aggressive driver, it's better to be able to hear that and get out of the way., because I'm not putting my life on the line...So the urban situations require you to have more of your sense available. Whereas in the rural situation, like if I am doing intercity trips. It gets literally boring, and I want more stimulation."*

The potential relationship between psychological flow and traffic flow was also highlighted by Expert 1, with them having the perspective and strong preference for continual movement stating, *"I don't mind slowing down at all, but having to put your foot down and wait for the light, it's almost jarring."* This low tolerance Expert 1 had for stopping they felt had to do with *"the agility of the bicycle, because you can figure out the way to make it through safely, even on a red light. Whereas, if you're a pedestrian you don't have enough speed.... With a bike you can look both ways, see if there is any car traffic and before any threat or another car turns, left or right on the next intersection you're already through."* In fact, Expert 1 further remarked, alluding to flow, on how they found a lot of enjoyment in the challenge of trying to figure out an optimise their respective cycle route choices so that they don't have to stop at a red light declaring, *"I will spend all this mental energy [to ensure this]. It's a lot of processing... but all that processing, is still worth it."* Expert 1 continues, *"To start your bike to go from zero to... your cruising speed, you're using a lot of energy... it takes more energy to be stuck behind a red light rather than spending that energy and coasting through a green..."*

This perspective of continual traffic flow preference is interesting to compare to some of the findings of Expert 4, who had written their master's thesis on the topic of group cycling flow in elderly populations. Expert 4 found that, in the case of this age demographic, a stop had the opposite effect stating, *"At least in the group of elderly, intersections are not always bad for flow. Sometimes they are very happy to wait because that means that they can catch their breath... they're not bothered ... by having to wait."* This thus contributes to the notion emphasized by Expert 2 and some of the literature (Verkade, 2021) that flow can be very individual, dependent on the person and their given context.

#### *5.4.2.2 Cycling's role in Placemaking & Urban Vitality*

Expert 1 spoke about the concept of "outdoor room", spaces like town squares or plazas that requires very narrow streets, building facades, "one lined up one against the other... a single-family home won't create that feeling", and minimal traffic. He compared how this concept can feel rather alien to those from North America, *"and that applies to cycling too. People who have not experienced, Dutch cycling, do not understand what it means to have 80%, 90% mode share on a street. This experience of for every 20 bicycles, there's 1 car, that experience. You can't... reasonably explain it to people. Even in a video, I can't. That feeling cannot be invoked... The experience sells it.... So that's my response to vitality... and placemaking."* In relating this to recreational cycling and context outside the city Expert 1 talked about mountain bike trial making, *"it's a real science... mountain biking is almost literally about flow."* It was further discussed if perhaps a similar set of principles or research into course design could curtailed for the recreational context.

With Expert 3, the utilisation of CROW principles was discussed with the Expert stating, *"[Such] principles should guide the design and evaluation of cycling infrastructure... it would be interesting to*

*investigate the compatibility between these design values, flow, and vitality. It may be that different design principles are necessary [in the recreational context], but maybe the current ones suffice."*

Expert 4 added to this by stating, *"I think vitality should be [present] outside of the cycle road."* Coming again from the perspective of studying cycling flow in elderly populations, Expert 4 felt it was important that the cycle paths themselves should not become too busy, but rather there should be interesting a vibrant place to stop and rest along the route. This they felt would really add to the experience, especially for more vulnerable population like elderly cyclists.

#### *5.4.2.3 Flow, Urban Vitality, & Placemaking: The role in recreational cycling planning*

Regarding the difference between commuting and recreational cycling, Expert 2 stated *"I think one of the most important dimensions probably is that commuting is very individual and goal oriented... recreation cycling often happens in groups or at least duos and that already immediate changes [the dynamic]."* They go on to talk about how there should be a greater priority on safety in this case, as part of the recreational cycling experience often involves taking with those who you are conducting the activity with. Thus, one's attention is already tends to be split more so that in the case of commuting cycling. Expert 2 continues to elaborate on the reason that recreational are particularly interesting as they allow for *"more social and spatial engagement [where] you actually need to go out of the city because this requires ... lowering of the challenges so that you can do [those things]"* He continues by stating the utility of the skill-challenge matrix, *"sometimes I want to go fast on my racing bike I will use different routes for that ... When you go out cycling recreational it's often it's less goal oriented but often more planned, so you already think about more where you cycle to while commuting is more of a habit and that doesn't change that much [allowing] you then to be in flow because you don't have to think about it anymore. But... I wouldn't be surprised that you find that people ... already take this into account like this skill-challenge threshold.... I always find fascinating that we don't have this language of flow, so we don't talk about it in that way, so people use different words."*

They go on to describe how people in these cycling scenarios likely, at times experiencing but are not able to voice that is what is happening to them. In relating this to how may use flow as tool in the route planning process of recreational cycling, Expert 2 compared makes a comparison to hiking routes. Often in the hiking context, the multiple routes that one can choose from in the same area, *"there's an easy one, medium level, hard and you try to pick the appropriate level of challenge."* He suggests that a robust flow-based recreational cycling network would adapt a similar principle, as flow can be a very individual experience. Therefore, different people will have a different skill-to-challenge ratio for them to reach in order to enter into flow, so ideally a network should be dense enough to give cyclists multiple route choices.



## 5.5 Combining Insights



Figure 72. Route Analysis based on frequent comments from the surveys and interviews.

### 5.5.1 Route analysis and Flow theory overlay

On the page above, a map was developed to sub-divide the sections in order to dive into the a further analysis of the aspects that participants associated with certain areas of the course. The size of the font corresponds, to the frequency each aspect of a particular subsection was mentioned in the survey and interviews.

In the first part of the course, section 1a, participants overall found this area to be unappealing, often describing this particular urban fabric as ugly. Many were not a fan of the bicycle lanes which required them to share the road with cars. When asked about this during the interviews, the reponses ranged from this being a stressful experience to one that required a greater level of alertness.

In section 1b and 2a, several participants commented on the red asphalt bicycle path, for many it felt like a nice change from the bicycle lanes shared with cars in section 1a, to dedicated bicycle infrastructure (section 1b) to cyclists having clear priority (section 2a). A few commented on the transition created by the tunnel enjoying the change from a mixed urban area to semi—urban neighbourhood, with many particularly enjoying the architecture of housing in this area. At both the transition from section 1a to 1b and from section 2a to 2b, several participants mentioned an increased sense of alertness, driven by a worry that otherwise they might miss the turns and be off course. This heighten sense of arousal is reflected in some of the trials' EDA data, with some typically small but noticeable data spikes occurring at this time.

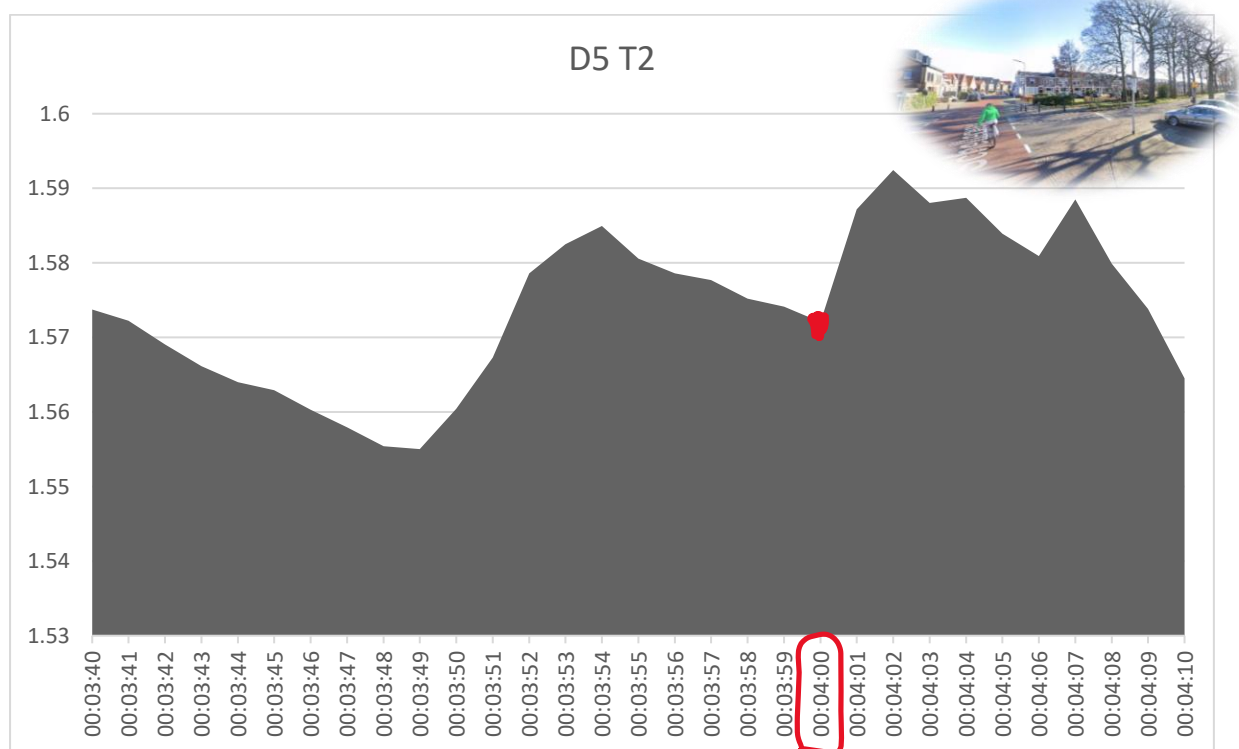


Figure 73. Zoomed in chart of participant D5 T2. At the 4-minute mark they missed this turn on Section 2, a small data spike follows. Source: Self

In section 2b, participants commented extensively on the trees, enjoying them both for their aesthetic quality, and for the shade, coverage and protection from the elements that the coverage helped to provide. This was also a design aspect that was discussed with Expert #, who speculated that use of tree-lined roads might help to add a sense of identity (placemaking) and vitality to recreational cycle routes, by providing the qualities mentioned above, as well as helping to frame the space of the cycle

path by providing clear boundaries and a 'roof' to the space. Participants also felt that the neighbourhood setting this path was set in was quite 'beautiful'.

In section 2c, participants continued to enjoy the tree-lined aspect, as well as the transition beginning to more a rural landscape. There were garden plots on the east side of this section that several participants also highlighted as an enjoyable aspect. Toward the end of this section a, participants stated feeling a small sense of worry, wondering if they were still going the right way. In their interviews, they stated this may have stemmed from the length of this tree-line section, creating a sense of anticipation for an upcoming turn. However, in the following transition zone from here to section 3a, many participants commented that this is where they felt, most in the moment, or in 'flow'. When asked why, respondents typically claimed that this variation of naturalistic features here helped to amplify this state of mind. In fact, the most frequent comment on section 2 as a whole was the degree of variation present throughout both natural and architectural features, that help to contribute to the level of enjoyment felt in this section, even if participants did not feel like they entered in flow.

In section 3a, many participants enjoyed the transition to a rural landscape, the greater presence of animals such as horses, and the fact that there were hardly any cars in this section. Many characterized this part of the course as 'peaceful'.

Section 3b, where participants were up on the dike, was also big favorite, with several participants stating they felt most in the moment here. They particularly enjoyed being surrounded by nature, with the river IJssel to their south and a pasture lands to their north. A few participants even stopped quickly on this section to take pictures of the views, particularly of the river and the bridge, Hanzeboog.

Throughout Section 4, the overwhelming majority of participants described this part of the course as boring, feeling that there was little to nothing to see. Since this part of the course ran along the rail-line, it felt long, grey and mundane to many. There were a few who enjoyed this section, however or least aspects of it, particularly that it was a dedicated cycle path with no, though some were also not a fan of the concrete slabs since it was not a continuous surface, nor of the concrete that separated each direction, feeling like it had some collision potential.

For Section 1c, participants did not offer much additional, mostly commenting that they could sense they were in the final stretch of the bicycle ride. One participant, D 5 T1, did mention that he was wary of some ducks that were crossing the cycle path. This may account for some of the spikes that can be seen at the end of his trial. (see chart below)

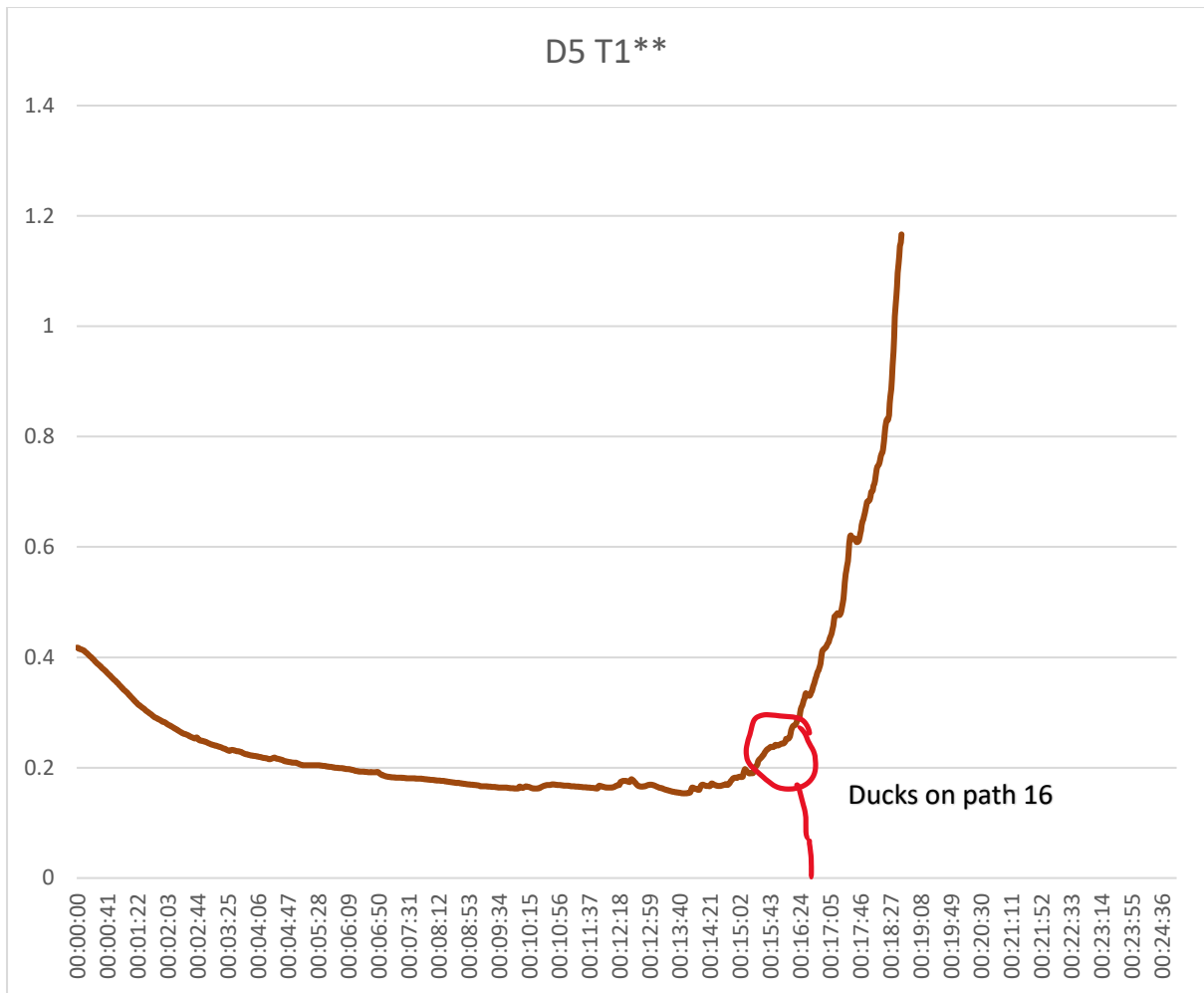


Figure 74. Chart of participant D5 T1, with approximate time they encounter ducks in the middle of the cycle path. Source: Self

### 5.5.2 Relationship between EDA Data & Key Areas of interests

Here 4 trials are highlighted to take a deeper dive into the potential EDA correlations with that of areas of interest in the course.



Figure 75 Comparison chart of 4 selected Trials, at 4 selected course locations, paired with their autotelic personality scores. All data sources are zoomed into different scaling lengths, as the point of this visualisation is to help analyse the general trends, *n* not the degree of change in ( $\mu S$ ). Source: Author

These 4 trials were picked to showcase a good sense of variance between participants. Here 2 females (D2 T1, D5 T3) and 2 males (D2 T3, D3 T2) participants with a variance in autotelic personality scores compared above. Different weather conditions were present with participants D2 T1 and D2 T3 experiencing rainy and windy weather, participant D2 T3 experiencing cloudy, slightly windy weather, but with no rain, and participant D5 T3 experiencing a nice sunny day. Participants D2 T1, D3 T2, and D5 T3 stated that their experience overall was a positive one, with each of them giving indications that they may have at some point entered a state of flow, with participant D3 T2 outright stating so. However, to characterize the ride as whole, they seemed to identify more with the term relaxing. Participant D2T3, was quick to state that the ride was not long enough for him to enter a state of flow, and that the experience was overall not enjoyable in the moment, was typically stressful, but was never boring.

These 4 areas were picked for further analysis due to the higher frequency from which they came up during the surveys and participant interviews. The transition area between Sections 2 & 3 was picked due to the high degree that it was mentioned as a favourable part of the course in the survey. This is where several participants indicated during the post-ride interactive interviews that they may have been in Flow. Participant D3 T2 even stated as such directly, quick to point this out at beginning of the interview. Participants enjoyed this area due to the variety of scenery present within this section. Participants mentioned how there were both nice homes and gardens to look. Animals such a bird and occasionally horses were present in this area. The transition also from a large tree canopy covering the road, to evermore countryside scenery, with smaller, younger trees lining the area, was something that several participants mentioned and pointed out on the map during the interactive interview.

In the case of the EDA data collected from this section, the trend is that is moves in a downward direction in 3 out of 4 of these trials. For participant D3 T2 who specifically mentioned that this where they may have experienced Flow, the trendline moves downward quite smoothly overall. For participants D2 T1 and D5 T3, the trendline moves downward in a more jagged pattern. Participants D2 T3 is the only participant whose data move more overall in an upward direction, with a jagged pattern. It may be also interesting to note that this participant had the lowest autotelic personality score. Despite this, participant D2 T3 did state that Section 2 was one of his preferred sections (check back is specific mention of transition zone) but, based on the video data and our conversation, was sometime during this transition into section 3 that the rain and wind began to pick up and thus causing him to look for temporary cover quickly afterwards.

The dike (Section 3b) was picked for a similar reason, as it too was often the cited as one of the more favourable areas in the survey. Many participants backed this up in the post-ride interactive interviews by stating that this part of the course was where they felt most in the moment, in the zone, in presence with the experience. These participants emphasized the nature, and the views present during this section. The river, wildlife like birds, pasturelands, the bridge, Zwolle, and other towns in the distance as were all highlighted. Occasionally mentioned was also the presence of other people out biking, walking, or taking out the dog as another comforting and cosy factor of this area. Several also mentioned that lack of cars in these sections was a large factor contributing to their enjoyment. However, opinions were more mixed on these sections, particularly due to the greater exposure to weather elements on the dike, Participants D2 T3 for instance, found this section particularly unpleasant due to strong headwinds and cold rain coming down during this part of his ride.

The EDA data samples here for this section all appear to be at least somewhat different. For participant D2 T1 who stated that this was her favourite section, and when she was most in the moment, has a smooth line of data in a downward trajectory. For participant D2 T3, who stated this was his least favourite section, the line in U-shape, as the data starts to move in an upward trajectory roughly halfway through. In the conversation with this participant and in his corresponding video data, you can see that this is when the rain and wind really start to come down on this participant, with him even covering his forehead for a period to keep it warm. Participant D3 T2's line is smooth at first then becomes quite jagged. (Check for more clues) It is not exactly clear base on the interactive interview why this may be the case, through a look through the video footage, there does appear to be some picking up of the wind, as well as some rattling coming down the dike and toward the beginning of section 4. Participant D5 T3's data also moves overall in a downward trajectory, though compared to D2 T1 there is a more jaggedness to this data's movement (check for more details). This participant also stated that it was in this section where they felt most in the zone and in the moment.

The transition up to the dike was included here due to the presence of topography (albeit limited) and change in road surface from asphalt to brick pavers, to see what effect, if any such environmental factors might have on the EDA data trends.

In the trials D2 T1 and D2 T3 where weather conditions were cool, rainy, and windy, the data trend moves downward appeared to move smoothly downward, appearing as if this topography and surface had little effect on their respect skin conductivities. For trial D3 T2, when the weather was slightly cool and slightly windy, the EDA data trends smoothly upward. For trial D5 T3, where weather relatively warm and sunny the EDA data trends in a very jagged pattern during this part of ride, sharply up and downwards.

Section 4 was included due to the high degree of frequency that participants seem to agree that this section was boring, due to its long straight character with limited changes to the scenery. In 3 of the 4 trials reviewed here, the EDA data trends in a downward direction here. In trial D2 T1, a relatively smooth downward trajectory is continued from the overall trend of trial. Trials D2 T3 and D5 T3 also have down trajectories during this section, albeit more jagged or undulating than with D2 T1. Trial D3 T2 is the only trial of these where their trendline rises markedly. Upon further review through the interactive interview, the participant recalled that there was an alarm that suddenly went off from one of the nearby buildings. Checking back through the video, this alarm can be heard at approximately the same during which his EDA data shifts markedly upwards. Hence a correlation between these two events can be confirmed.

## 6 Discussions and recommendations

In this section, the above-mentioned research questions shall be answered. This shall be done by discussing the inter relations within the theoretical framework, as well as the relationship between the theory and the empirical material gathered as presented in the results section. Hence, the findings discovered during the expert interviews and trials shall be discussed and backed up with sources from the theoretical framework that help to support these claims.

Furthermore, recommendations will also be made pertaining to what should be improved upon in future trials and research.

### 6.1 Answering the Main Question:

***How can exploring the inter-relations between the psychological concept of flow with that of placemaking and urban vitality, contribute towards improving planning for recreational cycling?***

Exploring the inter-relations between the psychological concept of flow with that of placemaking and urban vitality can provide insights into how an urban planner could develop recreational cycling environments that are conducive to flow experiences. To create the conditions for such conductivity, cycling routes should be designed that are aesthetically pleasing, safe, and provide opportunities for social interaction (as highlighted by Dutch Cycling Embassy, 2021; Te Brömmelstroet et al., 2021; Baxter, 2020; Bruntlett and Bruntlett, 2018).

As was highlighted throughout the series of expert interviews and participatory trials in this thesis, it is worth considering that potential recreational routes run through areas with interesting, diverse, and layered architectural and natural elements. Based on participant responses, semi-urban areas appeared to be preferred in this case, due the blending of various styles of home architecture with that of various green spaces like gardens. Nature, and naturalistic elements like that of trees, fields, natural water bodies, and the presence of animals, both wild and domesticated, were all noted as qualities that added richness to the experience. These are all qualities that hark back the CROW design principle of attractiveness (Gorris, 2023; Dutch Cycling Embassy, 2021; Subiza-Pérez et al., 2019). On several occasions, most notably from participant D5 T4, it was emphasized that routes that displayed variation of the above elements throughout were more enjoyable. From these insights, it can be inferred that variations of aesthetically pleasing elements tend to keep people actively engaged in their experience. They are more present, and in the moment, as the course continues to stimulate them with the variety of changing naturalistic and architectural elements, hence also adding to the repeatability of experiences in a given route.

The primary issue of safety that cyclists face is their interaction with motorized vehicles. In practice this means that interactions with cars should be minimized (Gorris, 2023; Bruntlett and Bruntlett, 2018; Steinburg, 2014). This means ensuring that wherever possible, a recreational cycle network with its own segregated paths that preferably take an alternative to a given destination from that of cars (Kruger, 2006). For instance, a given road reaches a town or village by going around a forested area, cycle planners may consider having their route run through the forest instead. In areas where cars and cyclists must share the road, design elements should help to ensure that cars are slowed down, to at least 30 kph, thus dramatically reducing collision fatalities between these modes (Dover and Massengale, 2013). Design elements such as narrower road widths, speed bumps, and tree-lined roads



help to contribute to this (Bicycle Dutch, 2021; Weijermars and Wegman, 2011; Dover and Massengale, 2013).

Social interaction can be created by intentionally incorporating stopping points and points-of-interest along a route. This can be done by running routes along or near viewpoints, adding amenities like seating and tables to create opportunities to stop, eat, and meet other cyclists along a route, thus creating and adding to the sense of vitality (Liang et al., 2022; Wang et al., 2022; Lunecke and Mora, 2017).

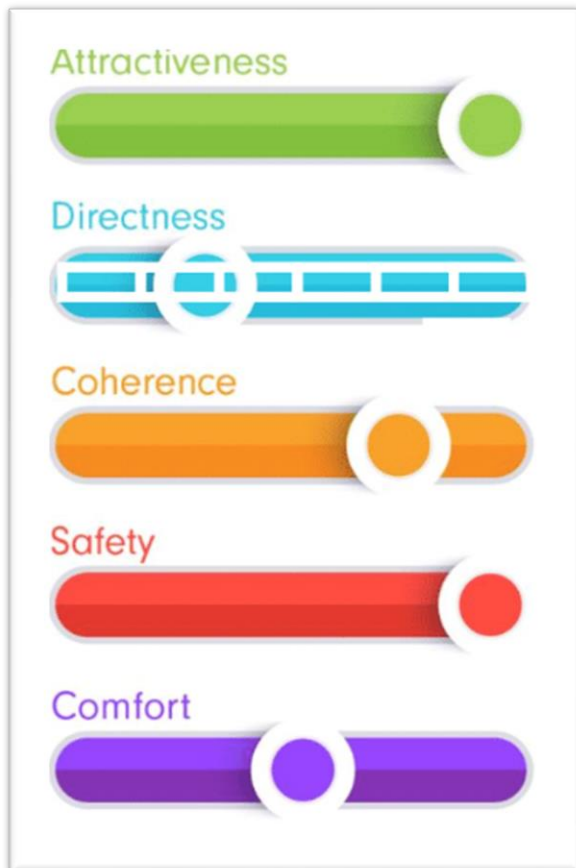


Figure 76. The suggested priority of CROW principles so as to best optimise for Flow in the recreational cycling context, Source: Mobycon Powerpoint 2022

As was emphasised by both participants, Experts 2 and 3, and reiterated in the above paragraphs CROW principles would serve the recreational cycling well, but they must be adjusted to better optimise for flow in this context. The principles like safety and attractiveness should also be a top priority. Coherence follows as a good principle to be mindful of on the network level. At least some comfortable routes should be offered, but the range of comfort can vary by route to offer more potential options to meet different skill-challenge levels (Te Brömmelstroet et al., 2021). Directness should have the lowest rung of priority on such a network, as taking a longer more vibrant route, will likely produce more flow experience than say a long straight direct one that follows a road. (Gorris, 2023; Dutch Cycling Embassy, 2021; Dutch Cycling Embassy, 2021d).

## 6.2 Answering the Sub Questions:

### ***In what ways can understandings of planning concepts like placemaking and urban vitality contribute to enhancing recreational cycling?***

Understandings of concepts like placemaking and urban vitality help to ensure that recreational cycling routes are developed not just as passing areas to go from A to B but rather as quality spaces and places in and of themselves (Wycoff, 2014). Ideally, different route choices themselves, will have their own sense of identity, allowing for a recreational cycling network, to be enhanced into plethora of leisure and recreational places connected through the activity of cycling (Bruntlett and Bruntlett, 2018; Kruger, 2006). Vitality is added to the network by ensuring that cycling remains a popular leisure activity throughout this network of places, that fosters a sense of social interaction between participants, adding to the quality of life for locals, and the attractiveness for tourists (Alex, 2022; Willemen et al., 2010).

Different types of placemaking along with various CROW principles can be utilised to respond appropriately at different planning levels and parts of the process, to enhance the vitality of both specific routes and the entirety of a recreational cycling network. Standard placemaking, along with the CROW principle of cohesion might be best utilised at the network level, to ensure that an abundance of quality recreational cycling places is present all throughout the network (Gorris; 2023; Project for Public Spaces, 2019).

Strategical placemaking is best utilised at specific corridors, routes, or nodes, thus, to best enhance the physical form, respective land uses and functions to increase the bicycle-friendliness of specific recreational routes (Wycoff, 2014; MIplaces and CNU, 2020 p. 24). In turn, such strategies may help to address the remaining principles of CROW in targeted routes, minimize unnecessary detours (directness), enhancing primarily safety and secondarily comfort, and ensuring a plethora of attractive qualities along routes, like green spaces, water features, quiet streets, and amble variety (as emphasized by participants) are present (Subiza-Pérez et al., 2019; Gorris, 2023)

Creative placemaking might be best utilised to enhance the vitality of specific gathering spaces or points-of-interest along a route. It could also be used to better incorporate the ideas of often underrepresented groups like children through say collective artworks/ activities (Markusen and Gadwa 2010; Wycoff, 2014). Furthermore, local knowledge and histories could be incorporated to routes in the form of plaques, via participatory endeavours with the local elderly populations. Thus, additional layers and variety may be added to routes, enhancing their potential to meet the criteria of the attractiveness principle, and thus become quality places within the larger mobility network (Dutch Cycling Embassy, 2021; Steuteville, 2014).

Tactical placemaking along with the CROW principles of safety and comfort could be used to test out quick, cheap, and reversable ways transform land uses and enhance social opportunities (Project for Public Spaces, 2021; Gorris 2023). Using cones or planter boxes, car speed on shared roads could be slowed down. As recommended by Expert 4, the placement of rest stops along routes could also be tested and adjusted in this manner to the best optimise the experience for vulnerable users, like elderly populations, and consequently the comfort and safety of routes for everyone else, before permanent alterations are made (Lydon, Garcia and Duany, 2015; Steuteville, 2014).

Recreational, rural, and nature-based forms of placemaking could be incorporated throughout various levels of planning. This could range from general principles to targeted initiatives enhancing the vitality of the network. Setting a focus on to recreational and leisure activities, engaging with and creating valuable healthy public spaces for rural communities, and harnessing the power of nature, all help to

target the principle of attractiveness within these spaces (USDA, 2022; Dutch Cycling Embassy, 2021). Furthermore, these processes help to address major challenges to the vitality potential of this context, like low population density, through creating like accessible recreational green corridors, and in turn fostering a sense of 'Pride in Place' (Lebisch et al., 2020, p. 57, Shaw, Wherley, 2021, Garling and Kenny, 2022).

### ***What are the potentials and limitations of the concept of flow regarding improving planning for recreational cycling?***

The concept of flow has enormous potential as a concept to help enhance participation in planning processes. By engaging with potential users of recreational cycling facilities, planners can ensure new designs and route choices not just by minimizing stressors, but that they also add to the attractiveness of these spaces by optimising for aspects that enhance the positive emotional experiences of various individuals. This can be done by leveraging the power data collected through sensors, surveys, and methods (Fathullah and Willis, 2018). Routes elicit more positive associations when they consist of a sequence of high-quality diverse experiences that enhance flow and contribute to vitality. Thus, such routes are more likely to be used continuously, benefiting both locals and the tourist sector (Lew, 2017).

However, as was best summarised by both Expert 2, and supporting articles and publications (Verkade, 2021, Te Brömmelstroet et al., 2021), individuals' ability to achieve a sense of Flow can be very personal. A route that offers an adequate balance of skill and challenge to one individual, may not do so for another. That is why developing a network that offers an abundance of route choice would be most preferential from a psychological flow perspective, as it would allow the wide range of individuals to be able to achieve and maintain a sense of flow.

On a similar note, Expert 2 also made sure to mention how the Flow state itself should not be thought of as the only desired state of mind. *"Try to avoid being stuck in the flow logic ... flow sometimes you actually don't want to be in flow,"* going on to describe other potential desired mental states like that of runner's high. The point being made here that flow is not the only state of mind that we should be designing cycling routes (recreational or otherwise) around. The question of how to best measure the flow state in cycling or other transportation context is one that still requires more research (Te Brömmelstroet et al., 2021). Future trials with larger samples, and researchers better equipped to analyse quantitative data should attempt to measure data accuracy. As previous studies have demonstrated, it tends to be easier to measure negative emotions like stress, than it is to measure positive emotional counterparts (Horvers et al., 2021). I imagine this may continue to be a big challenge and limitation moving forward.

Flow Theory itself may provide a rich cacophony of different emotional states that may be optimised for producing desirable cycling outcomes. For example, the state of relaxation, defined in this case as a state in which one's skill level is greater than one's sense of challenge, but not so much greater that one becomes bored. Relaxation was the description that most participants used to describe the course and their cycling experience overall. Considering how most participants stated that they enjoyed their experience, with many indicating on the survey that their mood had improved somewhat after the ride, routes and qualities of a route that help to further induce or enhance feelings of relaxation, should also be considered in recreation cycle planning.

***In what ways could a mixed methods approach contribute to using the concept of flow in improving planning for recreational cycling? How may this be done in a manner that is both reliable and repeatable, for the purposes of future use and research?***

As is hopefully demonstrated in this thesis, a well conducted mixed methods approach can be used to better triangulate aspects of a recreational cycling route that help to induce a state of flow or least help to induce other positive states associated with Flow Theory such as arousal, control, or relaxation. In this case, qualitative methods like literature analysis, surveys, and expert and participant interviews were used to cross examine and triangulate results found from quantitative data like area maps, EDA sensor and camera data. Literature and route maps were used to examine the context of Zwolle (The Netherlands), in which the trials took place. In the trials, the surveys, EDA, camera, and map data were all used in combination to help support the participant interviews. These were in turn further bolstered by the expert interviews, as is demonstrated in the *Combining Insights* section of the results chapter. As is hopefully clear in this chapter, all these insights are in turn further triangulated utilising the existing literature present on examined topics.

It is this triangulation and the participatory manner of this mixed methods approach that offers the most promise in terms of broadening understandings of how to utilise the concept of flow to improve recreational cycle planning.

“We see the increasingly blurred nexus between urban- and cyberspace enabling transformation...” (Fathullah and Willis, 2018) thus leading to processes of ‘co-production’ in planning. Digital technologies help to address some participation issues in urban planning, making it more accessible for participants to shape the development of their neighbourhoods.

Moving forward, perhaps the project in Denmark could consider incorporating a similar combination of qualitative and quantitative methods to make the development of the National Recreational Cycling Network more participatory. By developing a more streamlined, user-friendly version of this process – say a through the creation of a Flow app, that connects with devices like Fitbit, the participation barrier could be lowered. Thus, data gathered from a much wider range of participants could be incorporated. That way the upcoming recreational cycling network could be better optimised to provide flow possibilities for a wider range of potential users.

### 6.3 Flow & Recreation Cycling interrelations.

Expert 1 offered an interesting personal anecdote in relation to his cycling commute, *“In the West people tend to lack any sort of interaction with their environment, we lack any sort of discomfort cause by the climate, the weather... so I kind of enjoy it when I leave work when I have the cold wind in my face or the cold downpour. Just to remind me the I’ve been in a building all day, and the planet out there exists. So it’s a connection to nature, you suffer a bit.”* Such an insight also reminds of a statement made by participant D2 T3 in reference to how he would put this cycling experience into the category of what he called *“type-2 fun”*, this idea that the experience was not fun or enjoyable in the moment but will have been worth doing when reflecting on this. Such insights make me reflect more on the concept of Flow Theory, and its relations to the cycling experience. The attempt to measure positive states of mind can often be a challenge as they are often not so clearly separated from feelings typically perceived as unpleasant. How this relates to recreational cycle planning may prove to be interesting, as many individuals appear to agree that greater connection to nature was a factor, they would like to see more of in cycle routes. However, to what extent people see this in terms of a trade-off with comfortability, (in that they would prefer to take a cycle route that was more in nature, even it meant they were more exposed to environmental factors like wind and rain) would still need to be researched

further. For those willing to make such trade-offs, this may be thought of in the flow terms, of balancing skill and challenge. Here the presence of environmental challenges, creates discomfort and provides an additional layer of challenge to some. This serves as a continual reminder of this connection to nature, thus keeping one more engaged and more in the present moment. Under such conditions, a cyclist might become one with the course, assuming that the presence of such nature forces does not cross over into the territory cycling stress.

The section below highlights some experimental and methodological recommendations that could potentially be useful for conducting similar research in other contexts.

## 6.4 Experimental & Methodological recommendations

### 6.4.1 Investing more sensor data

In addition to EDA data, the Emotibit device also collected a variety of other data sample types like heart rate, heart rate variability, skin temperature, etc. (full list and details present in the methods section). In the interest of time and simplicity, this data was not analysed in the case of these trials. Previous trials related to the topic of stress and cycling/ the urban environment used skin temperature data for instance to help cross-reference, and more accurately confirm the difference between stress peaks caused by experimental stimulus and that with no such correlations (sources). Similar cross-referencing techniques could be used in future trials and research to better triangulate and confirm the stimulus sources, as opposed to what was simply done in these trials which can be chalked down to an observation of the given data correlations.

Furthermore, other emotional sensor types like Electroencephalography (EEG), that measures electrical activity in the brain might also be worth exploring in any future research connecting Flow Theory, to cycling, placemaking, urban vitality, or other urban planning concepts (Enders et al., 2016; Werner, Resch and Loidl, 2019; Nazemi and van Eggermond, 2020).

### 6.4.2 Collect GPS Data

For future runs of these trials or related experiments, I would highly recommend the use of a GPS tracker device or app. This will potentially make the connection between EDA or any other emotional data, and where that occurred on a given course far more seamless than the comparative analysis with video footage that needed to be done for this thesis.

### 6.4.3 Better Routing Techniques

Based on the experience with these participants, should similar trials be repeated, it might be worth reconsidering the wayfinding technique that was used. Despite best efforts to develop a simple route and mark it appropriately with chalk-paint arrows to indicate each given turn, explain the route before the trials, and even allowing participants to take a picture of the course for reference, two participants still managed to get lost on the route. For many others, it can be observed in video data that at times they appear uncertain as to if they are still on the right course and are seen checking their phone for reference to ensure they are going the right way. This of course, likely had an impact on the results, as correlations can be seen between this observed behaviour and spikes in the EDA data.

I would recommend that future trials be run with the participants following behind or riding alongside a researcher. This would be the best method to ensure that no participants get lost, nor do participants have to actively worry about directions. They can instead focus purely on the ride experience itself,

minimizing external factor that may take them out of, or act as a potential barrier to a flow experience. Another alternative could be for the bicycle to be mounted with a mobile phone or similar device, displaying the route map, an indicating to participants when turns are coming up. This would certainly be less disruptive than if participants take out their phones out of their pockets to check the map, thus reducing the said barriers. Still may serve as a potential distraction, causing some participants to look more often at this display than their surroundings, thus creating disruptions to potential flow or other state they may otherwise have been feeling. So as a means to reduce external experimental stimuli, I think ride-along with a researcher might be the best option attempt in future trials. This would better align with the conditions one may experience in a typical recreational cycle ride. One may or may not have any particular route in mind and is thus more likely to have an organic experience, where detours are taken and unplanned stops are made, focusing more on the journey itself rather than the destination.

#### 6.4.4 Camera

Perhaps camera placement could have been more optimal. Goal here was to have an angle where you can mostly see the participant's face as well as be able to see a bit of the background so as to identify where on the course the participant is. With more preparation and resources, one can imagine a similar run of such trials where two cameras used. One placed a higher more direct angle relative to the participant's face; The other, a front facing camera, dedicated to capture the surrounding environment. Of course, in this scenario, that additional data from two cameras, either must be accounted for the total trial time or some system would have to be developed to better optimize the upload.

As was originally intended, a 360-degree camera lens could have also been used instead of the traditional lens, that way you can capture both the ride scenery and participant interactions all at the same time. However, the insv format utilised by the 360-degree lens proved much more difficult to work with (requiring one to download a separate application, many of which are locked behind a paywall, to view said format) than the more common mp4 format utilised by conventional lenses. Hence, in the interest of time, and efficiency working with a conventional camera lens with .mp4 format was the simpler choice.

#### 6.4.5 EDA Data Reflections

Data from the wet electrodes used appears to be far more reliable than that with the dry electrodes that came with the Emotibit device. For one, clipping events (blatant errors) occurred far less often with the wet electrodes than with the dry electrodes. Furthermore, when the data was cross-referenced with the video footage and what the participants said in the interviews, the data spikes appeared to be more correlated with this in the wet electrode, than dry electrode trials.

Nonetheless, based on the results found in these trials, EDA data alone is not sufficient on its own to get a sense of if a participant may be in Flow or some other positive emotional state. As previous research has demonstrated (source), EDA sensors and data collection methods are better suited to collecting reliable data on negative emotional states such as stress, as stress can be more typically measured by some sort of induced stimuli, thus correlating to a stress peak in the data.

However, with the support of both additional quantitative (video, other sensors) and qualitative (surveys, interviews, etc.) there does appear to be some promise that through a process of cross-

referring states like Flow, and the natural and built factors that help to induce them, can be triangulated.

Ultimately, this thesis project served simply as a proof-of-concept for this mixed method approach. More data samples are needed to more definitively declare that any meaningful trends can be found between EDA and the flow state.

#### 6.4.6 Collaboration with other relevant fields

In future research on Flow Theory and its relation to cycling (recreational or otherwise) and other facets of transportation and urban form, the inclusion of voices from experts in other fields would prove to be extremely valuable. This thesis was conducted from an urban planning perspective, but for the same or similar topic it may also be valuable to study it from the perspective of psychologists, neuroscientists, architects, landscape architects, transport planners, engineers, IT specialists, experts in human-computer integration, to name a few.

The addition and collaboration of such perspectives would likely prove immensely valuable in the triangulation of flow's potential utility in improving the quality, sense of identity, and attachment we have to our built environment (Bonaiuto et al., 2016).

## 7 Conclusions and Implications

### 7.1 Conclusions

The results and discussions presented in this thesis help to garner several conclusions regarding the inter-relations between the psychological concept of flow, placemaking, urban vitality, and their implications for recreational cycling planning.

Firstly, exploring the inter-relations between flow, placemaking, and urban vitality provides valuable insights into the development of recreational cycling environments that promote flow experiences. The design of cycling routes should prioritize elements such as aesthetic appeal, safety, and opportunities for social interaction. Incorporating diverse architectural and natural elements, including green spaces, natural water bodies, and wildlife, enhances the attractiveness of the routes and contributes to the overall flow experience.

Safety is a crucial factor in recreational cycling planning, particularly in terms of minimizing interactions with motorized vehicles. Segregated paths and alternative routes that separate cyclists from cars can significantly improve safety. Traffic calming measures, such as narrower road widths, speed bumps, and tree-lined roads, can help reduce the risk of collisions and create a safer environment for cyclists.

Creating opportunities for social interaction along cycling routes is another important aspect of planning for recreational cycling. Incorporating stopping points and points-of-interest, such as viewpoints and amenities like seating and tables, encourages cyclists to pause, socialize, and contribute to the sense of vitality along the routes.

The CROW principles should be considered in the planning of future recreational cycling networks. However, the prioritization of these principles may differ in the context of recreational cycling. Directness may be of lower priority, as the focus is on providing an enjoyable and immersive experience rather than reaching a destination quickly. Coherence, safety, and attractiveness emerged as top priorities, ensuring that routes offer diverse experiences, enhance safety measures, and provide attractive qualities that engage cyclists.

Placemaking and urban vitality concepts are valuable tools for enhancing recreational cycling. By treating cycling routes as quality spaces and places, rather than just thoroughfares, planners can create an abundance of attractive and diverse recreational cycling places interconnected through the activity of cycling. Different types of placemaking, such as standard, strategic, creative, and tactical placemaking, can be applied at various planning levels and specific corridors or nodes to enhance the physical form, land uses, and functions of the routes. Involving local knowledge, histories, and the natural environment adds layers of meaning and variety to the routes, making them more attractive and engaging.

Flow has significant potential for improving planning for recreational cycling by enhancing the positive emotional experiences of cyclists. Engaging with potential users and collecting data on their experiences can help ensure that designs and route choices not only minimize stressors but also contribute to the attractiveness and enjoyment of the spaces. However, achieving a sense of flow is a highly personal experience, and providing an abundance of route choices is key to accommodating individual preferences and optimizing flow experiences. It is also important to recognize that flow is not the only desirable state of mind, and other emotional states, such as relaxation, should be considered in recreational cycling route planning.



## 7.2 Implications

Through the findings, this study offers several implications for the planning and design of recreational cycling environments.

The CROW principles should be adapted and applied in the context of recreational cycling. Directness need not be a primary focus, like it should be in the commuting context. With recreation, the emphasis should be on enjoyment and immersion rather than simply getting to one's destination as fast as possible.

First and foremost, planners should prioritize the creation of cycling routes that offer diverse and engaging experiences. This includes incorporating a variety of architectural and natural elements, ensuring safety through separate paths and traffic calming measures, and providing opportunities for social interaction along the routes. By considering the inter-relations between flow, placemaking, and urban vitality, planners can create environments that enhance the overall quality of the recreational cycling experience.

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## Appendices

### Appendix A: Expert Interview Questions

#### **Introductory questions**

What is your area of expertise? Interest? Specialization? Etc.?

What got you interested in these topics?

How has this shaped the way you view topics like planning, mobility, (recreational) cycling, etc.?

Are you an avid cyclist? How often do you bike in a week?

#### **Analytical questions**

How do you understand 'flow' within the planning/ mobility context?

Have you heard of psychological flow? If so, what is your understanding of the concept?

From your perspective, how could the concept of flow be used in improving planning for recreational cycling?

What is your understanding of urban vitality? From your perspective, what are the inter relations between urban vitality, recreational cycling, and flow?

Are you aware of the CROW cycle manual? From your perspective, how could the CROW cycle manual contribute to linking urban vitality and the flow concept?

What is your understanding of placemaking? From your perspective, what are the inter relations between placemaking, recreational cycling and flow?

Placemaking in different places? City? Countryside?

#### **Normative questions**

How do you see such concepts in the 'recreational cycling context? From your perspective, how could connecting urban vitality, placemaking and flow improve planning for recreational cycling?

How could you imagine psychological flow contributing, or relating to these concepts? Alternatively, how might you envision new constructs around planning and mobility being shaped by taking a closer at people's flow state?

## Concluding questions

Do you have further questions for me? Could you point me to data that might be useful for my study?  
Do you know of other people who might be a possible interviewee for this study, and could you connect me to them?

More on regarding these expert interviews will be discussed in the results section.

## Appendix B: Shopping List

<a href="#">External Computer Hard Drive</a> OR <a href="#">Media Markt Alternative(s)</a>  <a href="https://www.coolblue.nl/product/861840/samsung-t7-portable-ssd-1tb-rood.html">https://www.coolblue.nl/product/861840/samsung-t7-portable-ssd-1tb-rood.html</a>	€ 99,90
<a href="#">X4 high speed SD cards (For 360 cam)</a> OR <a href="#">Media Markt Alternative</a>  (Based on specifications for Insta 360)	€ 17.99 per card  Marijn has these.
<a href="#">High speed SD card reader (For 360 Cam)</a> OR  Media Markt Alternative	€ 8 - € 20  Marijn has this.
<a href="#">Battery (For 360 Cam)</a>	€ 41.99 € 58.99 (Fast Charge Hub)  I think we can run it with one battery and possibly an external battery pack.
<a href="#">Multi-plug</a> or <a href="#">Amazon options</a>	€ 11.02  This will be at the office in Zwolle
X1 (pack) Pen	Store
Paper	Store
X2 Clip boards	Store  /In Zwolle
X4 <a href="#">EDA leads</a> * OR X2 <a href="#">EDA Leads</a>	€ 12.99 (few days delivery)  Or € 9.95 (next day delivery)  Are we sure these are compatible?



	<i>Robin said the front appear compatible with the electrodes, but we will need to solder the ends to the device</i>
Adhesive tape (For EDA leads)	store
<a href="#">Solder kit</a>	€ 6.55 (if we don't have) Lennart to check at home.
X4 <a href="#">Spray Paint</a>	€ 19.96 (with shipping)
Voice Recorder	We have? Lennart has this.
Bike rental	Robin mentioned potential partner (Deelfiets Nederland) / Get participants to use their own bike? Alternatively rent OV fiets: € 4.25 per day
Screws for EmotiBit case	Robin sent message to Lennart about this

### Appendix C: Autotelic Personality Score chart

(Strongly Disagree = 1, Strongly Agree = 7)

	Strongly Disagree			Neutral			Strongly Agree
	1	2	3	4	5	6	7
Curiosity is the driving force behind much of what I do.							
I perform tasks even when they are difficult.							
When tasks get harder, I'll continue until I complete them.							
I care more about enjoyment of a task than rewards associated with it.							
I like solving complex problems.							

I enjoy routine work.							
*I find it hard to choose where my attention goes.							

\*This statement is reverse scored.

## Appendix D: Pre-ride questions

What is your gender?

Male

Female

Other

Prefer not to specify.

What is your age range?

20-29

30-39

40-49

50-59

60+

How would you rate your overall mood at this moment?

Very bad-----Bad ----- Neutral -----Good----- Very good

How many times do you cycle in a week?

0-1 days

2-3 days

4-5 days

6-7 days

For what are reason(s) do you cycle each week?

Work

Exercise

Running Errands

Recreation

All the above

None

What would you say is the average distance you cycle daily?

</= 500 m

1-2 km

2-5 km

5-7 km

7+ km

What would you say the average amount of time that you cycle daily?

Nothing

</= 30 minutes

1 hour

2 hours

> 2 hours

What would you say the average amount of time of a single cycling trip of yours?

Nothing

</= 30 minutes

1 hour

2 hours

> 2 hours

What type of area do you prefer to cycle in?

Rural

Semi-Urban

Urban

Other: \_\_\_\_\_

Why?

\_\_\_\_\_

#### Appendix E: Post-ride Questions

How would you rate your overall mood now, after the ride?

Very bad-----Bad ----- Neutral -----Good----- Very good

Did you enjoy the ride?

Not at all – Mostly not – only parts/aspects of it – Mostly – Entirely



Were any parts of the course more enjoyable? Where and why?

Section 1

Section 2

Section 3

Section 4

None

Describe: \_\_\_\_\_



Were any parts of the course where less enjoyable? Where and why?

- Section 1
- Section 2
- Section 3
- Section 4
- None

Describe:

---

If the experience (or aspects of it) were enjoyable, why?

Enjoyable in itself

For health reasons

For

other

reasons:

---

Was not enjoyable.

Throughout this ride how often did you feel a sense of complete concentration on the task?

Never – Rarely – Occasionally – Often -- Always

Did you ever feel a change in your sense of time?

Never – Rarely – Occasionally – Often – Always

If you did notice a change in the sense of time, in which way?

speeding up / slowing down / other

Did this experience feel rewarding in itself?

(YES / NO)

How often did you feel a sense of effortlessness or at ease on the ride?

Never – Rarely – Occasionally – Often – Always

How often did you feel adequately challenged?

Never – Rarely – Occasionally – Often – Always

Did you ever sense a feeling of merger between your actions and awareness during this ride?

Never – Rarely – Occasionally – Often – Always

Did you ever feel a sense of loss of control?

Never – Rarely – Occasionally – Often – Always

How often did you experience a sense of total focus on the task?

Never – Rarely – Occasionally – Often – Always

Did the weather affect your results?

(YES / NO)

#### Appendix F: Guiding questions for interactive interviews

We noticed a peak in the EDA/ stress sensor here (play back correlating video footage), can you tell us what happened/ how you were feeling?

We noticed a long consistent period in the EDA/ stress sensor data between X and X time (show correlating video footage), can you tell us how you were feeling then?

We noticed a period of little to no sensor data between X and X time (show correlating video footage), can you tell us how you were feeling then?

How often did you experience a sense of total focus on the task?

Never – Rarely – Occasionally – Often – Always

Were there any parts of the course, or moments during this ride where this feeling was more present? Where? (Check footage, check sensor data to see if any correlations can be drawn)

Present with maps of the course for them to highlight such areas.

Were there any parts of the course or moments during this ride where this feeling was less present? Where? (Check footage, check sensor data to see if any correlations can be drawn)

Grant space for participants to write descriptions and/or present with maps of the course for them to highlight such areas.

What **areas** of the course did you feel more drawn to/ wanting to cycle more in? (Check footage, check sensor data to see if any correlations can be drawn)

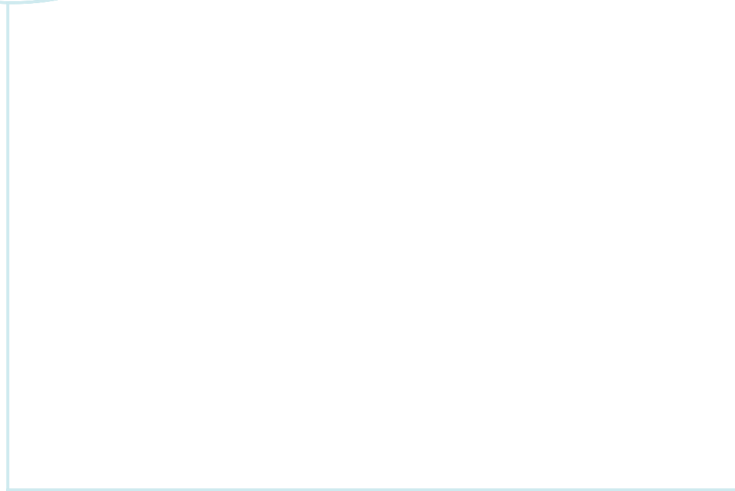
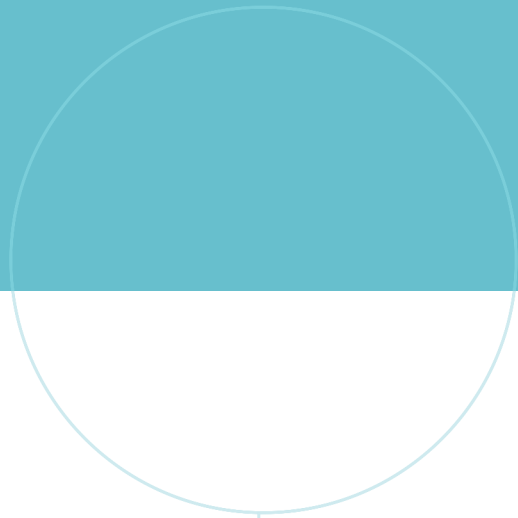
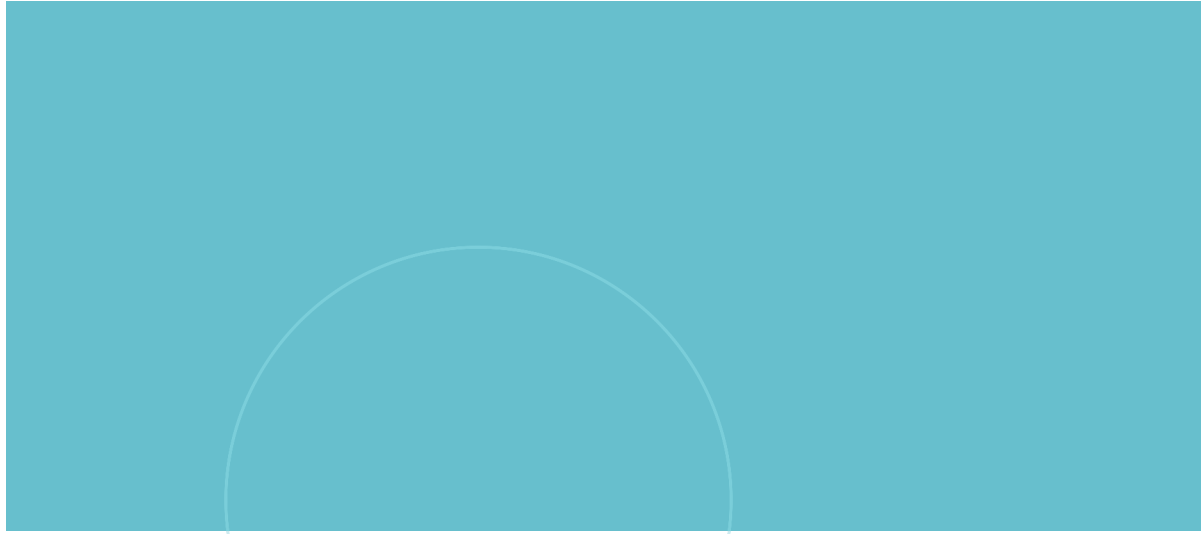
What **aspects or qualities** of the course did you feel more drawn to/ would make you want to cycle more? Green space? Variety of textures? Nice architecture? Busy? Quiet? Presence Other Cyclists? Straight or winding paths? (Check footage, check sensor data to see if any correlations can be drawn)

At what moment(s) / areas of this route did you *feel most in presence*? In other words, most in the zone of cycling?

What aspects would have made this ride more enjoyable for you? From environmental details? The bike quality? Other?

What aspects would have made you feel more in the moment during this experience?





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