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„Assessing the bikeability of the city of Vienna using the NetAScore toolbox for sustainable mobility."

verfasst von / submitted by

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Abstract

The growing population in urban areas increases demand for efficient usage of public space and therefore makes it necessary to strengthen new forms of mobility. Cycling can be seen as a sustainable solution to improve public health and help minimize traffic, pollution and raise the quality of living. Studies suggest that cycling trips are positively correlated with built environment attributes which is why it is necessary to build better infrastructure for biking. Deficits in the quality of the bike infrastructure cause risks in safety for commuters. This thesis contributes to the latest research on bikeability to foster mobility transition in cities by addressing the varying bicycle friendliness of a city, namely Vienna. This thesis evaluates a recently established index calculated with a toolbox called NetAScore published by the Mobility Lab which is part of the Z_GIS department at the University of Salzburg. For detecting both the potentials and the limitations of the index a mixed quantitative and qualitative approach is employed. Interviews with relevant experts in the field of cycle planning in Vienna were conducted. The index was evaluated by first customizing its parameters, then comparing the result with other planning specific data from the city of Vienna. Finally, suggestions for improvements to NetAScore were conducted.

Results showed that the toolbox is a helpful tool for researchers or students from the field of transport planning, GIS and other related fields with a technical background to evaluate a street network of a desired location. Since advanced computer skills and insight into GIS data is necessary to use and understand the toolbox, the public might not be able to use the tool. For the public sector that oversees planning cycling and walking infrastructure of a city, the toolbox and its result provide an overview of bikeability and walkability results of a city. This can be helpful at meetings with different players and to get an objective result of the measured street network. For a wider usage of the tool, it needs to be available online with no need to install data or software. For a more detailed result a few adaptations need to be made as worked out in this thesis. The analysis of the 23 districts in Vienna and its bikeability showed sufficient quality in classifying bikeability. Some problems still occurred concerning classifying segments wrongly since results always depend on the input data. For a more accurate result in Vienna, more detailed input data is necessary. It can be concluded that local administrative data and local knowledge of an area cannot be supplemented entirely by the results of the NetAScore toolbox.

Kurzfassung

Die wachsende Bevölkerung in städtischen Gebieten erhöht die Nachfrage nach einer effizienten Nutzung des öffentlichen Raums und macht es daher notwendig, neue Formen der Mobilität zu stärken. Das Radfahren kann als nachhaltige Lösung zur Verbesserung der öffentlichen Gesundheit, zur Minimierung des Verkehrsaufkommens und der Umweltverschmutzung sowie zur Steigerung der Lebensqualität angesehen werden. Studien deuten darauf hin, dass Radfahren positiv mit den der baulichen Umwelt korrelieren, weshalb es notwendig ist, bessere Infrastruktur für das Radfahren zu schaffen. Defizite in der Qualität der Fahrradinfrastruktur führen zu Sicherheitsrisiken für Radfahrer. Diese Arbeit leistet einen Beitrag zur aktuellen Forschung rund um bikeability, um die Verkehrswende in Städten zu fördern, indem sie sich mit der bikeability einer Stadt, nämlich Wien, beschäftigt. Diese Arbeit evaluiert einen kürzlich erstellten Index, der mit einer Toolbox namens NetAScore berechnet wird, die vom Mobility Lab des Fachbereichs Z_GIS der Universität Salzburg veröffentlicht wurde. Um sowohl die Potentiale als auch die Grenzen des Indexes zu ermitteln, wird ein gemischter quantitativer und qualitativer Ansatz angewandt. Es wurden Interviews mit relevanten Experten im Bereich der Radverkehrsplanung in Wien durchgeführt. Der Index wurde evaluiert, indem zuerst seine Parameter angepasst wurden und dann das Ergebnis mit anderen planungsspezifischen Daten der Stadt Wien verglichen wurde. Schließlich wurden Verbesserungsvorschläge für NetAScore erarbeitet.

Die Ergebnisse zeigten, dass die Toolbox ein hilfreiches Werkzeug für Forscher oder Studenten aus dem Bereich der Verkehrsplanung, GIS und anderen verwandten Bereichen mit einem technischen Hintergrund ist, um ein Straßennetz eines gewünschten Ortes zu bewerten. Da fortgeschrittene Computerkenntnisse und Kenntnisse über GIS-Daten erforderlich sind, um die Toolbox zu nutzen und zu verstehen, ist die breite Öffentlichkeit möglicherweise nicht in der Lage, das Tool zu nutzen. Für den öffentlichen Sektor, der mit der Planung der Rad- und Fußgängerinfrastruktur einer Stadt beauftragt ist, bietet die Toolbox einen Überblick über die Ergebnisse der Rad- und Fußgängerfreundlichkeit der Stadt. Dies kann bei Treffen mit verschiedenen Akteuren hilfreich sein, um ein objektives Ergebnis des bewerteten Straßennetzes zu erhalten. Für eine breitere Nutzung des Tools muss es online verfügbar sein, ohne dass Daten oder Software installiert werden müssen. Für

ein detaillierteres Ergebnis müssen einige Anpassungen vorgenommen werden, wie sie in dieser Arbeit zusammengetragen wurden. Die Analyse der 23 Wiener Bezirke und ihrer Fahrradfreundlichkeit zeigte eine ausreichende Qualität bei der Klassifizierung der Fahrradfreundlichkeit. Einige Probleme traten dennoch auf, da die Ergebnisse immer von den Eingabedaten abhängen und Segmente teilweise falsch klassifiziert wurden. Für ein genaueres Ergebnis in Wien sind detailliertere Daten erforderlich. Zusammenfassend kann gesagt werden, dass lokale Verwaltungsdaten und lokales Wissen über ein Gebiet nicht gänzlich durch die Ergebnisse der NetAScore Toolbox ersetzt werden können.

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Vienna, 11.11.2023

Content

Abbreviations

NetAScore	(Street) Network Assessment Score
PT	Public Transport
PASTA	Physical Activity Through Sustainable Transport Approaches
BMI	Body Mass Index
STEP	Stadtentwicklungsplan (City Development Plan)
SUMP	Sustainable Urban Mobility Plans
WHO	World Health Organisation
GIS	Geographic Information Systems
VCÖ	Verkehrsclub Österreich (Austrian Traffic Club)
OSM	Open Street Map
GIP	Graphenintegrationsplattform (Graph Integration Platform)
BI	Bikeability Index
BLOS	Bicycle Level of Service
BLTS	Bicycle Level of Traffic Stress
IHS	Interaction Hazard Score
RVS	Richtlinien/Vorschriften f. Straßenwesen (Guidelines road construction)
StVo	Straßenverkehrsordnung (Federal law for public streets)
T30	Zone with a speed limit of 30 km/h
SVI	Street View Imagery
ECF	European Cyclist Federation
OGD	Open Government Data

1 Introduction

Urban environments are in constant adaptation to fit the needs of its citizens. The shift in mobility patterns towards active mobility, public transport (PT) and sharing mobility is only a matter of time. Humans have lived in cities since 7000 BC and since then the city has been the place where people meet, interact, trade and commute. As cities grow, challenges appear and demand new solutions for transportation, living conditions and the economy (National Geographic Society, 2022). The transition of mobility to non-motorized and non-individual traffic can be seen as the challenge of this century. It is the duty of this generation to make cities a more livable, climate adapted environment. Fostering cycling mobility is one essential part of this transition.

This thesis aims to draw a picture of the aspects that make the biking experience a positive one with a focus on the city of Vienna. Cycling numbers in the city of Vienna more than doubled in the timespan from 1993 to 2019 from 3% to 7%. In 2023 the city has a 9% cycling share of all trips, with the aim to increase. The city of Vienna has great potential to improve its infrastructure and be a leading city when it comes to slow mobility, as it is the case with public transport in Vienna already, being very reliable and high numbers of people using it. According to the city development plan for mobility aspects 80% of all journeys in Vienna should be covered by either public transport, biking or walking by 2025 (Telepak and Magistrat der Stadt Wien, 2015). The Masterplan Biking 2015 - 2025 published by the Federal Ministry of Agriculture, Regions and Tourism (BMLFUW) has the aim to increase the share of bike traffic from 7 % to 13 % in the mentioned period (Heinfellner et al., 2015). In 2023, the city of Vienna is receiving a record amount of funding from the federal government for the expansion of cycle paths, around 28 million euros (Wien ORF, 24.07.2023). The new transition in mobility patterns is well known and supported by planning authorities and the city development agency already. The transition in mobility is a process that involves changes in technology, infrastructure and policies towards sustainable, shared, and connected modes of transportation, such as electric vehicles, biking or walking. Efforts must be made to integrate non-motorized mobility into everyday life by both designing adequate infrastructure and promoting other measures. Therefore, research in innovative mobility solutions is highly relevant nowadays. Studies suggest that cycling trips are positively correlated with built environment attributes which is why it is necessary to build better infrastructure for biking (Arellana et al., 2020).

Furthermore, cycling can be seen as a sustainable solution to improve public health and help minimize traffic, pollution and raise the quality of living (Krenn et al., 2015). Therefore, the population can be nudged into choosing forms of sustainable transportation more often by building better infrastructure for biking in urban areas.

This thesis intends to evaluate a recently established index calculated with a toolbox called NetAScore published by the Mobility Lab which is part of the Z_GIS department at the University of Salzburg (Werner et al., 2023). For detecting both the potentials and the limitations of the toolbox a mixed quantitative and qualitative approach will be employed. The index will be applied to the street network of Vienna. The used data comes from the Graphenintegrations-Plattform (GIP) as well as from the OpenStreetMap (OSM) database. This aims to answer how a street network can be quantified. Further, it described how the toolbox can be used in the best possible way to support the planning process and what aspects cannot be modeled with the toolbox.

The thesis aims to find out what limitations occur when using the index as a tool to evaluate the quality of bike infrastructure in Vienna. This is done by first introducing the theoretical background of the concept of bikeability and of indices in general. The term bikeability is getting more attention in urban planning in the recent decade. Still, there is no universal definition of the term (see chapter 4.1). Bikeability indices are a method of assessing bike friendliness and can be calculated based on different metrics like bike lane availability, type of lane, bicycle parking, intersections, traffic lights, speed zones, width of street or terrain (Winters et al., 2013). Dynamic aspects such as weather, shadow or traffic can also be considered (Buehler and Dill, 2015). These metrics can be weighted according to the specific use case.

Almost 30 papers were analyzed according to their methods, calculations and results in the subject of bikeability to give an overview of previous research and to define the gap this thesis aims to fill. Further, expertise from people working in a related field in the city of Vienna was gathered to understand local conditions and to estimate the potential of the NetAScore index. The expert’s knowledge helped customize the NetAScore index to fit the needs of the city. In the assessment study of this thesis, the accuracy of the NetAScore index and its correlation with related data sources was conducted.

1.1 Problem statement

Efficiently using public space by fostering new forms of mobility can be seen as the general background of this thesis. With this work the author would like to contribute to the latest research on bikeability to foster mobility transition in cities. This thesis is of high relevance because the topic of biking in urban areas comes more into focus and cycling can be seen as one key aspect of transforming cities to more livable places.

The mentioned index, NetAScore, will be applied to the street network of Vienna to calculate the bikeability. Since the index has only been used in the city of Salzburg this will be done for a greater diversity in study areas. Other aspects that make the NetAScore index stand out against previous indices are described later in this thesis. The research done at the mobility lab in Salzburg at the Z_GIS department is strongly focused on applying their knowledge on practical applications. Since the NetAScore index has been established recently there is no research done yet that uses and evaluates the index. Besides that, there is no bikeability index that uses GIP data so far (Werner et al., 2023). Furthermore, the thesis shows the technological possibilities that can support the planning process and thus also encourage decision makers. High quality models of transport networks such as bikeability indices are necessary to strengthen bicycle mobility in urban areas. Combining this with new technologies in the field of GIS, new possibilities appear (Zagel and Loidl, 2020). A bikeability index that is well designed can be a tool for worldwide usage and can help cities to pinpoint areas where cycling infrastructure and other interventions are most needed and prioritize investments accordingly (Winters et al., 2013). Because of the publication of the index, it can also help emancipate citizens by giving them the opportunity to be involved in the process.

The aspect of safety is the most important factor, according to literature and expert opinions, to consider when studying the subject of cycling in cities. As our cities and populations grow, traffic issues and modes of transportation stand out and because of these developments the bike as a mode of transport seems like the perfect solution for traffic and space issues in urban areas. Large investments and campaigns, shared bikes, financial benefits for cargo bikes and so on have been made by cities authorities to help promote biking. Still the numbers of cyclists stagnate. Safety concerns (real and perceived) are most frequently mentioned as a restraint to ride the bike in the city.

To have safe roads for both cycling and walking is even proclaimed by the World Health Organization (WHO) as a part of promoting sustainable transport (Loidl and Zagel, 2015). Cycle planning is always geared towards improving road safety. However, quality and comfort must not suffer from this. Having a good data basis as well as analyzing and making conclusions with GIS is crucial for improving safety issues.

Different numbers from travel surveys suggest that cycling has high potential. In the US, 42 % of all trips taken by private vehicles are one mile or less, 25% are 3 miles or less based on data from the U.S. national survey of personal travel activity as stated in a paper by Kellstedt et al., 2021. These are perfect distances to take the bike. Similar numbers can be found for cities in Europe. In Austria, 37% of trips taken to go to work are less then 5 km, showing they can be potentially taken by a non-motorized mode of transport. In Vienna, 70% of all trips taken to work are less then 10 km based on data from 2014 (Wolf-Eberl and Posch, 2018). This shows that there is huge potential for an even greater change in mobility patterns.

EU policy makers are aware of that potential. Research relating to the correlation of active mobility and health issues are tackled with the PASTA (Physical Activity through sustainable transport approaches) project, an EU project with the aim to generate knowledge about the promising link between active mobility in cities and health. For people who are normally less physically active, this can be addressed by changing their form of mobility. Simply by changing their way in commuting they can integrate a moderate form of activity in their daily lives (Wegener, 2017).

Transport planning goals, for example those published with the Sustainable Urban Mobility Plans (SUMP) by the EU can be a strategic background and lead cities towards improving active mobility modes (European Commission, 04.04.2023). In fact, the EU even recently declared that they would release an EU declaration on cycling within summer 2023 stating that the goal is to double the amount of safe cycling infrastructure and have EU finances targeting those issues. E-Bikes especially and therefore needed infrastructure should be improved, being an important factor in connecting rural areas. As Executive Vice-President Frans Timmermans put it, at a keynote speech at the Cycling Industries Europe Summit 2023:

> “Biking is by far the cleanest and most affordable form of transport. That's why decision makers at COP26 in Glasgow fully recognized that taking action to

boost cycling in our cities and regions is in fact, taking climate action." (Cycling Industries Europe Summit, 08.05.2023)

A strong political will is the most impactful force when improving active mobility infrastructure and investments according to stakeholder interviews in selected EU cities. Political will often lacks because of the fear of losing voters, lack of finances and the problem that multiple institutions and planning sectors need to collaborate but are scattered in their responsibility. This leads to inadequate cycling infrastructure and therefore lack of public visibility and acceptance (Wegener, 2017). Missing or low proportions of cycling rates in everyday traffic are often caused by structural deficits or bad traffic organization. Numerous examples show that the share of cyclists in the distances travelled can be significantly increased by means of incentives (Meschik, 2008).

There is evidence that current mobility patterns can be modified. Changes in structure (urban structure, living conditions, road space) lead to changes in people's behavior if guided well. For example, sport events or large-scale roadworks that are announced beforehand show that people can act flexibly if told early on. In fact, a survey of cyclists showed the relationship between adherence of rules and bike friendliness in correlation (Brezina, 2017).

The personal motivation of the author of the thesis is that she sees her professional future within the domain of planning bicycle mobility in urban areas because she is convinced of the benefits of biking. As of September 2023, the author will be working for the mobility agency Vienna to improve cycling infrastructure and promote cycling and walking in Vienna. As an experienced cyclist who daily commutes in Vienna, the author knows the problems of the bike network but also the chances for improvement. The author wants to find out what methods are necessary and useful for best evaluating the street network according to the needs of cyclists and wants to get insights into the planning process in Vienna.

1.2 Relevance

This thesis can be seen as the first one using a multi-methods approach for testing the NetAScore toolbox. This is relevant for the further establishment, publication and development of the NetAScore toolbox. The toolbox is freely available and accessible

via GitHub and can be used for detecting cycling and walking quality of all areas of the world. By June 2023, this is the only index published of that kind. It can be seen as a unique selling proposition of the toolbox that it is fully transparent and reproducible. It is possible to customize settings for its calculation as well as use desired datasets or even combine them. No other bikeability index that was studied for this research has these features. Further, Vienna's bike network has never been analyzed with this method nor in this level of detail. Different datasets, GIP data and OSM data were combined to get a result of each street for its quality of biking. Further, the main target audiences were contacted and interviewed. This shows a clear image of how useful the toolbox is, how much potential it has and how it can be adapted. Further information on the impact of the index, how it can improve the planning process and further advantages and disadvantages can be found in chapter 7 and 9.

This thesis is of high relevance because cycling needs to get even more attention. Activistic groups, like *Platz für Wien* is, calculated that Vienna's road network is 17 times as long as its cycle paths. The total length of the cycle paths in Vienna is 1700 km. But only 170 km are separated cycle lanes, that allow much more safety and comfort. Most lanes are of mixed use with traffic or pedestrians. When looking at road space, two-thirds of the road space in Vienna is available for car traffic, although only one-third of the inhabitants own a car (Platz für Wien, 28.04.23). Spatial models like the NetAScore toolbox are essential when planning new infrastructures and when promoting sustainable commuting. Therefore the geospatial approach that the toolbox and this thesis are taking show new possibilities and outcomes.

When it comes to considering spatial factors when promoting active commuting, meaning cycling and walking, there is a lack in research. Still, spatial factors have a considerable impact on the movement of people. In contrast, mobility shapes the physical and geographical characteristics of space (Mobility lab, 20.07.23). As Sallis et al., 2016 found out when analyzing 14 different cities, the factors residential density, intersection density and availability of parks have direct impact on physical activity of residentials underlying that the design of urban environments has the potential to induce people to active forms of mobility.

Cities should plan according to what they want (e.g. less parking spots or more space for bike lanes) not for what they have (wider streets). This contrasts with the belief in

supplying demand. Supplying demand in a city where 30 % use the car (Vienna) would mean improving infrastructure for cars (Arellana et al., 2020). Also, the misbelief that wider streets lead to less traffic can be given as an example here. Wider streets and more lanes lead to more traffic because driving a car is being made more attractive. The term induced demand is used to describe this phenomenon (see also Chapter 5.3). According to Larsen et al. 2013, demand will arise when infrastructure is built. “Built it, they will come”, as he analyzed in a study in Montreal, Canada. Dill and Carr, 2003 also analyzed this phenomenon within 42 US cities. There was a significant correlation between more bike ways and higher cycling rates, they found out. Still, the presence of bike lanes alone is not the only factor that has to be considered. Lanes need to connect important destinations as well as policies that encourage cycling are necessary to increase cycling rates (Dill and Carr, 2003). Contrarily, it can still happen that without proper planning newly built infrastructure might not be used as intended (Arellana et al., 2020). Therefore, the planning process of finding the right location for new facilities should have priority.

Another relevant aspect is that promoting higher cycling rates can tackle public health issues, for example physical inactivity. There is great potential in optimizing the daily commute. Because these trips are necessary, people will always be mobile. There is a need to find a sustainable way of being mobile. Habits, like taking the car, are hard to break. When trying to reach people and nudge them into other ways of transportation the social and physical environment and attitudes and social values need to be addressed (Loidl et al., 2018). Exposure to accidents and air pollution are risks to consider when using slow mobility forms but are outbid by the positive effects that active commuting has on the health and environment (Loidl et al., 2018). There is even evidence that the BMI (Body Mass Index) can be reduced by simply walking, biking or taking public transport in contrast to taking the car (Martin et al., 2015).

The European Cycling Federation (ECF) estimated the total annual benefits that cycling can achieve (see figure 1). It is based on an annual cycling distance of 146 billion kilometers. Only aspects that are possible to being quantified show up in the calculation. The real number can be expected to be even higher.

Benefit	Estimated Value (billion euros)
CO_2 emissions savings	0.6 – 5.6
Reduction of air pollution	0.435
Reduction of noise pollution	0.3
Fuel savings	4.0
Longer and healthier lives	73
Less sickness absence at the workplace	5
Bicycle market	13,2
Cycle tourism	44
Easing of road congestion	6,8
Saving on construction and maintenance costs for road infrastructure for motorised vehicles	2,9
Total annual benefits	**150 - 155 bn euros**

Figure 1: Financial Benefits of cycling in the EU, source: European Cyclists Federation

The impact of the recent Covid Pandemic on the way people commute must be mentioned here as well. The Covid pandemic has shown how important public spaces and the ability to exercise are. A certain share of people who used to use PT converted, during and after the pandemic, to use the bicycle. As the pandemic showed it is important to have an alternative to PT that is environmentally friendly and has a low risk of infection. This can be seen in the share of people who cycle in Vienna. Numbers were stagnating around 7% before 2019 and are now at 9% and expected to rise. The pandemic is one influential factor for the increase (Fahrrad Wien, 08.05.2023).

Since it is well known that cities need to address issues around traffic by fostering slow mobility, investments have been made for increasing biking and walking numbers. Numbers vary but in general cities try to implement policies to promote cycling and increase cycling levels. When planning new infrastructure, the bike network needs to be seen as an entire system where it is important to have good and fast connections. Planning single bike lanes does not make sense (Buehler and Dill, 2016). A paradigm shift in the development and planning of public transport, the development of national cycling networks, new strategies on cycling and revised physical activity guidelines mark a turning point for cycling (Titze et al., 2010).

Factors like public attitude, cultural aspects, city size, income and climate are factors that affect cycling rates as well. This thesis only focuses on environmental characteristics. Socio demographics and location specific conditions may influence cycling rates as well but should not be examined in this thesis. Bike facilities should not be a response to cycling rates but more a cause meaning to encourage people to cycle the right bike infrastructure is needed (Dill and Carr, 2003).

The bicycle is a vehicle, it also belongs on the road and not on sidewalks and pedestrian areas. But it also needs to be protected, like pedestrians are. A meaningful cycle network must be structured in the same hierarchical way as the road network for motorized transport. The main network and infrastructure can be defined based on desirable lines of demand (destinations, temporal and spatial distribution of traffic). The higher the network hierarchy and the more important the connection, the faster, more convenient, efficient and direct the cyclist has to be routed (Meschik, 2008).

Bicycle sharing systems being implemented in cities is also getting common and therefore the concept of assessing infrastructure and its bikeability is timely (Ito and Biljecki, 2021).

1.3 Objectives and research questions

The aim of this paper is to provide an overview of the ways to measure the degree of bicycle friendliness of urban regions. The contributing factors are identified and existing methods for measuring bicycle friendliness are explained. Further, a recently established index that can measure the bikeability and walkability of desired street networks is being evaluated. It is calculated with a toolbox called NetAScore, available over GitHub (Werner et al., 2023). For the evaluation both qualitative and quantitative methods will be used.

To achieve the following objectives, the corresponding research questions are stated below.

Objective 1 Analyzing local conditions of the study area.

Research Question 1 What background local knowledge can experts on bikeability and urban planners reveal regarding aspects of Vienna’s bike network and the planning process that have not yet been scientifically examined?

Objective 2 Assess the NetAScore index with related data sources and a field review.

Research Question 1 What is the spatial variability when measuring bikeability with the NetAScore index in comparison to other available and relevant data in the city of Vienna?

Research Question 2 What aspects of bikeability can a field review-based analysis of a selected region of Vienna consider compared to the index-based analysis NetAScore?

Research Question 3 What improvements can be made to the NetAScore index based on the findings of a field review, qualitative interviews and a quantitative assessment?

1.4 Structure

The thesis is structured as follows. Chapter 1 introduces the topic, the main problem and the relevance of the field of research as well as the underlying objectives and research questions that will be answered. Chapter 2 describes the field of research and previous research gaps. Chapter 3 describes the methodology that is used in this thesis in detail. Chapter 4 aims to define used terms, describe what aspect influence cycling quality and how bikeability indices work. Further, it gives an overview of previously published indices and evaluates them. Chapter 5 lists international best practice examples of urban planning for bicycles. Chapter 6 introduces the NetAScore Toolbox with its technical background, workflow, datasets and guide of usage. Chapter 7 introduces the use case Vienna by naming relevant statistics. The content of the interviews is integrated into this chapter. Chapter 8 conducts the assessment study by explaining the technical set up, used data, customed metrics and by visualizing the main outcome of the index results. Further, an evaluation of each district is conducted as well as some small-scale maps. The field evaluation is described as a concept but not being applied in this thesis. This aims to provide a guide on how to apply a field evaluation if further interest remains in the topic. Chapter 9 covers the results of the assessment of Chapter 8 as well as the limitations of the work, further research gaps and the conclusion.

2 Related work

This chapter aims to give an overview of the research field around the topic bikeability and its placement within that field. The detailed definition of the used terms can be found in chapter 4. The terms bikeability, bikeability studies and bikeability research are used in this chapter and define the overall research field of this thesis.

The research of this thesis is done in a city in the global north and the reviewed literature and theory is mainly based on research from the global north. This needs to be mentioned because results may vary according to where bikeability is measured and how it is integrated in the planning process. 80 % of bikeability studies are published in the global north (Arellana et al., 2020). The Scopus review for the term *bikeability* (term used in title, abstract or keywords) proves that. There are 152 matches for this search as of July 2023. As shown in figure 2 most studies are published by the US, the UK and Canada, followed by China, Australia and states in northern

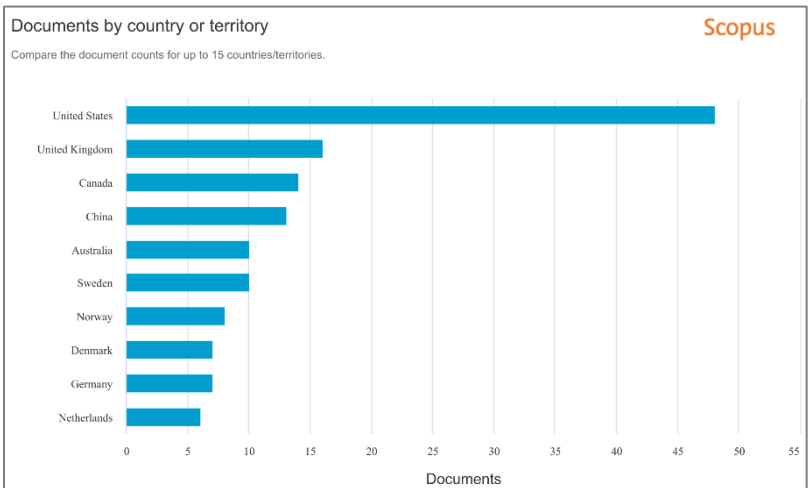

Figure 2: Scopus Review for the term Bikeability - Geographic variability, source: Scopus

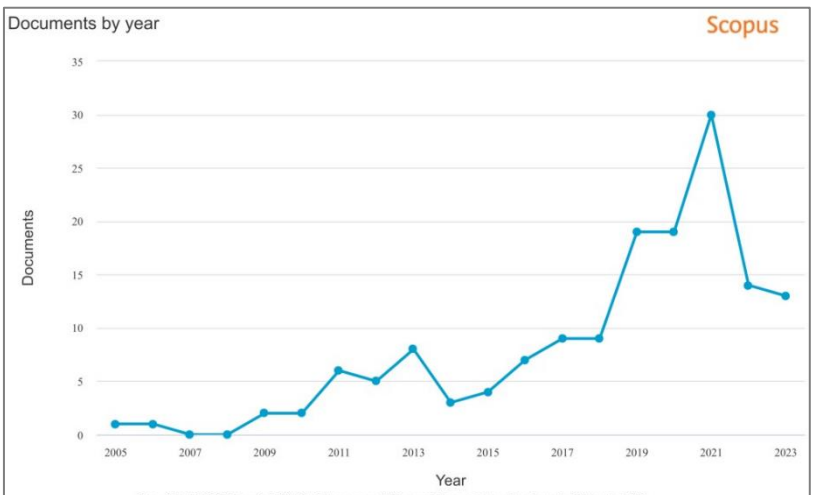

Figure 3: Scopus Review for the term Bikeability - Timeline, source: Scopus

Europe. As shown in figure 3, there are no studies prior to 2005. Further, there has been an increase in studies in that field in the last decade.

2.1 Development and placement of research field

Related research fields that overlap with the field of bikeability research can be summarized in the following way as pictured in figure 4. This is based on the papers and books studied within the period of March 2023 – July 2023.

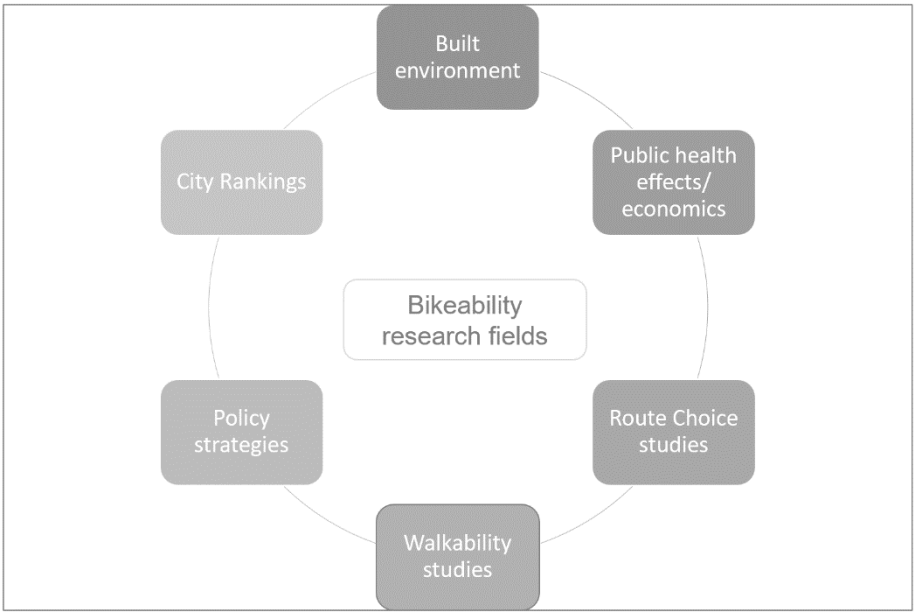

Figure 4: Overview Research Fields around Bikeability

The field of built environment is strongly connected to bikeability research. A growing number of studies examine the interaction between the built environment and its effects on cycling behavior and cycling rates. The built environment consists of attributes like physical infrastructure and urban structure (all physical elements). A more detailed description can be found in chapter 4.5. Cities with more bike lanes tend to have a higher share of cyclists. Therefore, cycling trips correlate with built environment attributes (Dill and Carr, 2003; Krenn et al., 2015; Wahlgren et al., 2010).

Research on the ranking of cities on a global scale according to their bikeability is another aspect that overlaps with bikeability research. This method ranks cities according to certain metrics and therefore direct comparison is possible. The *Copenhagenize Index* is one example (Copenhagenize Index, 05.05.2023). Here,

Vienna ranks 9th with a score of 60.7 %. A statement by Lorenz Siegel, a landscape architect at the company *Copenhagenize* states:

> "Vienna has great potential to become a leading city for sustainable transportation if it finally manages to interweave best-practice bicycle infrastructure with its world class public transport system." (Copenhagenize Index, 05.05.2023)

Studies that analyze the effects of biking on public health and the economy are mentioned here as well but should remain untouched in this thesis. The benefits biking has on public health are well documented and can be calculated and estimated.

A whole field of research within bikeability studies is dedicated to observing the route choices of cyclists and measuring the bikeability accordingly (Winters et al., 2010).

Walkability studies are related to bikeability as stated in chapter 2.2.

Bikeability can be measured and assessed differently. Figure 5 shows the most used methods of bikeability assessment or bikeability indices. The terms are defined in chapter 4.1 in more detail.

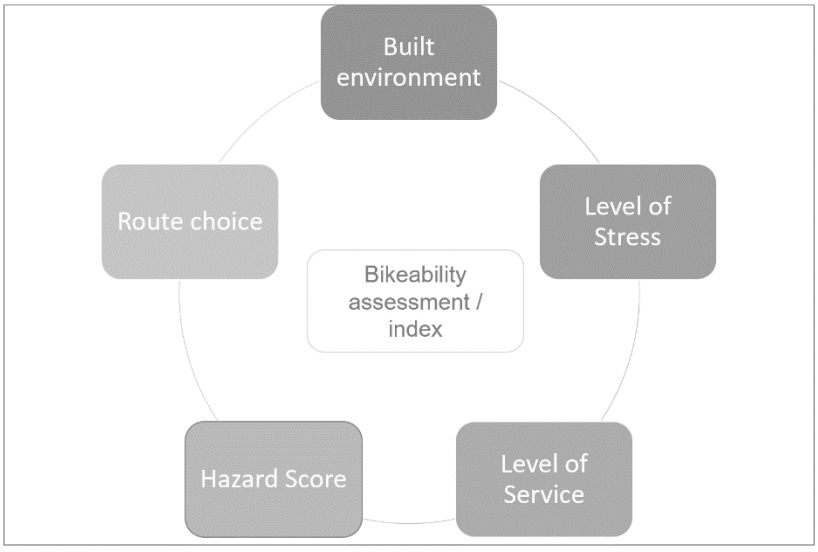

Figure 5: Methods of measuring Bikeability

To quantify non motorized mobility (walking and cycling) researchers mostly develop an index (various ones have been created) as an assessment method. The index is calculated based on different environmental characteristics (built environment) or perceived characteristics (Level of Stress). Therefore, each index is calculated differently and mostly only described verbally in a paper. Meaning the transferability to

other areas is not always given due to different conditions in each city. The replicability of a developed index demands expert knowledge or many participants taking part in a survey meaning a lot of effort, time and costs. To understand if the index really gives a good model of the reality on the streets many studies compare index results with data on cycled routes or with population density and its modal split (Winters et al. 2016). For more details on indices as spatial evaluation tools see chapter 4.2.

Depending on the aim of the study bikeability is assessed differently. For example the safety of the network, the holistic conditions for one city or the perfect location for new infrastructure can be different aims (Muhs and Clifton, 2016).

Literature that evaluates the route choices of cyclists (bicycle route choice studies) mainly states that separate bicycle infrastructure and low traffic volumes positively influence cyclists. Cyclists are willing to detour for these safety and comfort advantages (Gholamialam and Matisziw, 2019; Winters et al., 2010).

The term Level of Stress means the perceived stress cyclists experience when riding. This is a user centered approach. It is mainly based on the Dutch design principles by CROW (Rik de Groot, 2016; Boettge et al., 2017).

Bicycle Level of Service (BLOS) refers to the term Level of Service used in traffic planning. This means an evaluation of the quality of a network relying on categorical or continuous metrics. It was developed and first used by Landis et al. (Landis et al., 1997; Pritchard et al., 2019).

The Interaction Hazard Score was introduced 1994 by Landis with the aim to create a model to estimate the perceived hazards of cyclists on sharing roadways with cars (Landis, 1994). It is used by different studies to replicate, test or compare it with other assessment methods (Kellstedt et al., 2021; Pritchard et al., 2019).

2.2 Distinction Walkability

It needs to be mentioned that the terms bikeability and walkability have different meanings in previous literature and a different scope. Although both terms are meant to describe non-motorized mobility, the term walkability is far more often used and cited. Generally, more research has been done on walkability than on bikeability (Krenn et al., 2015). The terms have rare similarities. Those are that cycling and walking are

both human-powered, are exposed to weather and to the environment. They are both modes that need protection from traffic. The speed of travel and the distances traveled are dissimilar. The fact that walking trips in the city are mostly multimodal, meaning walking to reach public transport or other forms of mobility differs to characteristics of biking. According to findings from Muhs and Clifton, 2016 walkability is impacted by the density and kinds of land use and bikeability is more impacted by the infrastructure. Biking is more dependent on the completeness and connections within a network and the physical separation. In urban planning, pedestrians need to be treated differently than cyclists. Higher travel speed and travel distance require adequate infrastructure. As pedestrians need to be protected from car traffic, cyclists need this protection too. This tends to be overlooked. Cyclists are as vulnerable as pedestrians and therefore bike lanes directly in between moving traffic can be seen as unsecure. This is further described in the Book *Copenhagenize* by Mikeal Colville-Andersen and in chapter 5.3 of this thesis (Colville-Andersen, 2018). The NetAScore toolbox can be used for both walkability results and bikeability results for a selected area. Because different measures are required for both modes of transport, the results can not directly be compared. This thesis only focuses on bikeability and further only evaluates and uses the bikeability criteria of the NetAScore toolbox. Still the distinction needs to be made here since the terms walkability and bikeability are often named in the same context but in this thesis need to be distinguished.

2.3 Literature Classification

For this thesis, 26 selected papers on bikeability were analyzed according to the following categories (1 - 5). The full table of all papers analyzed is attached at the end of this thesis (see Table Appendix 1, chapter 11.5). The summary in Table 1 aims to give an overview of the used literature for this paper and its content and research strategies. The categories were established after reading the selected studies and are meant to understand the focus of recent studies and place the NetAScore toolbox within that field.

1) **Method of information gathering**: What method was used in the paper to assess bikeability?
    a) Qualitative: based on perception of cyclists, surveys, questionnaires/audits, gathered GPS data.
    b) Quantitative: existing data of streets attributes (OSM, administrative data)

2) **Area:** Where is the analyzed area located?

3) **Factors of analysis:** What factors were used to evaluate the bikeability? A more detailed description of factors, see chapter 4.5.

   a) Hard: All factors that consider build environment (infrastructure, facilities)

   b) Soft: subjective measures like perception of safety, political will, attractiveness

   c) route choice: studies that analyzed bikeability according to the route choice cyclists took (can be hard and soft factors)

4) **Spatial unit of analysis:** What spatial unit was used to analyze the area?

   a) city level: the whole city was analyzed as one unit.

   b) grid cells: manually assigned resolutions, for example 50m or 100m grid cells

   c) line segment: the street network is the data basis of analysis. Results in high detail.

   d) administrative level: (political) borders (more detailed than city level)

5) **Computation:** How was the result computed? This possibly provides information on how to replicate the study.

   a) Verbal: there is a verbal explanation of how the assessment was conducted. Therefore, it is harder to replicate the study.

   b) Equation: there is an equation or other mathematical explanations on how the result came about. Therefore, it is easier to replicate the study.

Table 1

summary of selected studies on bikeability*

Method	Area	Factors	Spatial Unit	Computation
Qualitative: 18/26	Europe: 15/26	Hard: 20/26	Grid Cells: 5/26	Verbal: 18/26
Quantitative: 7/26	US/CA: 10/26	Soft: 3/26	Line: 13/26	Equation: 8/26
Both: 1/26	Asia: 1/26	Route choice: 3/26	Admin. Level: 3/26	
	South America: 1/26		City Level: 3/26	

Note. *Studies Selected based on Scopus review, geographic variability, and citations. See full table in appendix (Table Appendix 1).

As seen in table 1 most of the studies were using a qualitative method to analyze bikeability. Most of the studies were conducted in Europe, followed by the US and Canada. Almost all studies analyzed hard factors. Most studies used line-based data and published a verbal explanation of their method.

The column replicability shows that all studies describe how they calculated the index but there are no available programmed or open tools. NetAScore is different here. The NetAScore toolbox can be categorized as seen in table 2. This describes what makes this bikeability index stand out against previous tools. Since the toolbox is published over a GitHub repository it is ready to use and therefore is not only a scientific study in theory but can be applied by users for their own area of interest. That is why it can be applied worldwide (depending on used data), which also makes it stand out against the others. It is best when it comes to user friendliness, transferability to other areas and easily usable for non-professionals.

This thesis is listed in table 2 as well because it can be mentioned alongside the selected bikeability studies. It uses both qualitative and quantitative approaches (as described in chapter 3). Only hard factors are being analyzed and it is described verbally how the methods were applied.

Table 2

Placement of NetAScore toolbox and this thesis

Author	Method	Area	Factors	Spatial Unit	Computation
Werner et al., 2023 (NetAScore, Version 1.0.0)	Quantitative	OSM: Worldwide, GIP: Austria	Hard	Line	GitHub Repository
Karl, 2023	Both	Vienna, AUT	Hard	Line	Verbal

Note. Comparable with table 1. See also Table Appendix 1.

2.4 Research gaps

As several studies mention, there is a lack of good quality data measuring how and where cyclists ride (Hardinghaus et al., 2021). So far, sources like travel surveys, manual counts or data collected with a GPS receiver have been used in studies. GPS data collected by cyclists is highly accurate and gives a good insight into the actual used infrastructure. This data can be used to evaluate the results of the index. Infrastructure investments cannot be targeted at the right places because of a lack of data of where cyclists ride. It needs to be mentioned that cycling rates are generally relatively low, which means more people must be surveyed to get adequate results. Even when there is adequate data it still only tells where people cycle not where they would like to cycle. Because people tend to use streets with cycling infrastructure, maybe they would be faster elsewhere but don't ride there because there is no adequate infrastructure. This is a common limitation in planning infrastructure and researching its need (McArthur and Hong, 2019).

According to Winters et al., 2013 and Loidl[1] methods for modeling non motorized traffic remain to be better developed. Data that measures the actual routes cyclists take remains to be collected. The commercial smartphone application *Strava* can be mentioned as a data provider, where cyclists track their routes to compare themselves to others although this remains to be trips of leisure and only a very specific group uses the app. Further, there is a well documented gender gap (Venter et al., 2023). The

[1] Martin Loidl, 10.03.2023, personal meeting, not transcripted

study of McArthur and Hong, 2019 uses *Strava* data to understand how cyclists travel in Glasgow by comparing *Strava* routes with shortest routes and searching for correlation within cycling infrastructure. To understand the actual travel patterns of cyclists and according to infrastructure improvements more specific data is needed. Only the detection of location of bike paths alone is not representative for depicting bicycle travel. The advantage of *Strava* data is that it can be collected by anybody with a smartphone and the app installed.

In general, the comparison of different indices is hard and therefore the overview of the literature (table 1) must be understood as a general overview. Since the metrics are not standardized, for example for the term hilliness, there is no standard measure. That's why every index gets different results for one city. This remains to be a problem when using the NetAScore toolbox and comparing it with other results.

A challenge is the study population of bikeability studies. Existing qualitative research mainly collected data for work purpose cycling. Meaning also, cyclists are a very heterogenous population. That's why a quantitative review is better for some cases. This thesis does not evaluate cyclists' choices or behavior, nor does it distinguish between different types of cyclists. Due to the quantitative mode of the study, this is not necessary because there will not be any survey for cyclists. It is only about how good the index depicts the infrastructure. Because of findings in different studies the importance of facilities for bikers is proven.

Because there is no general definition of bikeability or how to measure it the comparison between indices and between different cities must be treated with caution. Using Open Data that is widely available can be one way of dealing with that issue. Further, a consensual understanding of the term bikeability is necessary to analyze it (Hardinghaus et al., 2021).

Research addressing the relation between cycling numbers and bike infrastructure increased in the last years. Few studies analyzed the quality of networks and its influence on the behavior of bikers (Buehler and Dill, 2016).

To sum up, the thesis addresses the following shortcomings that were mentioned in other studies and therefore is of high relevance for the research field of bikeability.

- Defining the concept and term bikeability
- Systematic evaluation of influential factors
- Using open government data
- Transferability to other study areas and other spatial levels
- Assess bikeability in high spatial resolution with an automated process.

3 Methodology

This chapter describes the methodology of the practical part (chapter 6 to 8). The practical part consists of the following elements (see also chapter 1.3).

- **Expert Interviews** → Objective 1, Research Question 1
- **Index Calculation and Spatial Analysis** → Objective 2, Research Question 1
- **Field Evaluation** → Objective 2, Research Question 2
- **Improvements** → Objective 2, Research Question 3

3.1 Study Design

Figure 6 shows an overview of the study design of this thesis. The first grey block describes the literature review that has been explained partly in the previous chapters. An overview of comparable indices was given to understand how the NetAScore index fills up the research gap. Previous limitations were mentioned. Factors that influence the quality of biking in cities were extracted and listed in chapter 4.5. The next step included the conduction of the interviews, described in more detail in chapter 3.2. The index calculation with its analysis, comparison and maps followed. This all results in

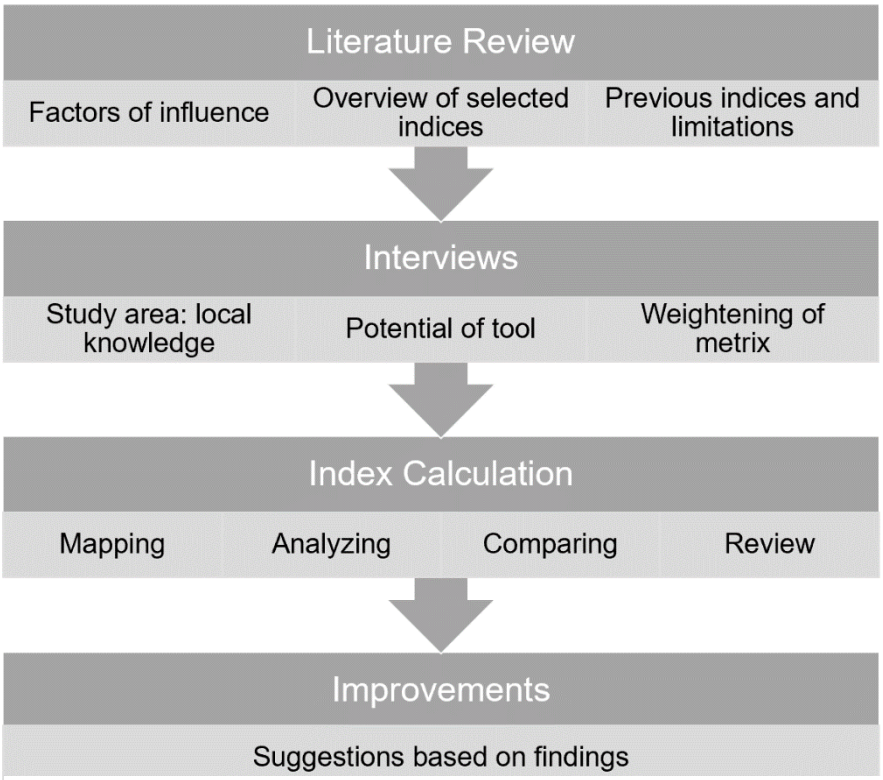

Figure 6: Study Design of this thesis

improvements and suggestions for the further development of the NetAScore Index and the results of the evaluation.

3.2 Interviews

This method was applied to answer the following research question:

What background local knowledge can experts on bikeability and urban planners reveal regarding aspects of Vienna's bike network and the planning process that have not yet been scientifically examined?

For this thesis experts were contacted and interviewed with the aim to understand local conditions of the study area, get background knowledge of spatial planning issues that are not mentioned in literature and to adjust the weighting of the parameters of the index (see chapter 8.1). Professionals from different domains, both public sector and NGOs (3 people in total) were asked open questions about special conditions to consider in Vienna that are not mentioned in the literature. With this background local knowledge, the index was adjusted accordingly, and the street segments were evaluated and depicted on a map using the mentioned index NetAScore.

The survey design of the interview and the questions for each expert are listed in the appendix of this work (chapter 11). All interviews took place in June 2023. Experts received open questions in advance of the meeting per email.

The expert interview is a qualitative survey method, in which the object of investigation is captured in a holistic form. In the process the focus is on describing, interpreting, and understanding facts and contexts. Qualitative interviews are very well suited as preparation for quantitative surveys (or other quantitative analysis). The interviews were tape-recorded and transcribed afterwards. Two experts wanted to stay anonymous, one expert was Roland Romano, representative of *Radlobby*, a federal association that represents the interests of all cyclists at the national level and international level (European Cyclists Federation). The interviews were held in German and translated to English afterwards. The transcripts can be found in the appendix of the thesis. The content of the interviews was summarized and contributed to chapters 6, 7 and 8.

3.3 Concept of Spatial analysis

This method was applied to answer the following research question:

What is the spatial variability when measuring bikeability with the NetAScore index in comparison to other available and relevant data in the city of Vienna?

To spatially analyze the data, it was necessary to find suitable methods to compare similarities and dissimilarities of the index and related data. To assess the quality of the index, other data sources were used for comparison: the main cycling network (in planning and in existence). In the city of Vienna there is no data on cycled routes or surveys about cycling behavior. Counting stations spread out over the city measure the number of cyclists passing by. These counting stations are situated on highly frequented routes that are well equipped for cyclists. Only 20 exist in Vienna (in comparison: Salzburg has 27 stations with a population of 152 000). For understanding all cycle patterns and dynamics and for getting a representative result, the data of counting stations will not be used to evaluate the index in this thesis. Data on the travel behavior is also lacking and not available open source (expert interview 1). Therefore, the official data on the main cycling network will be used for spatial analysis.

Process of Analysis:

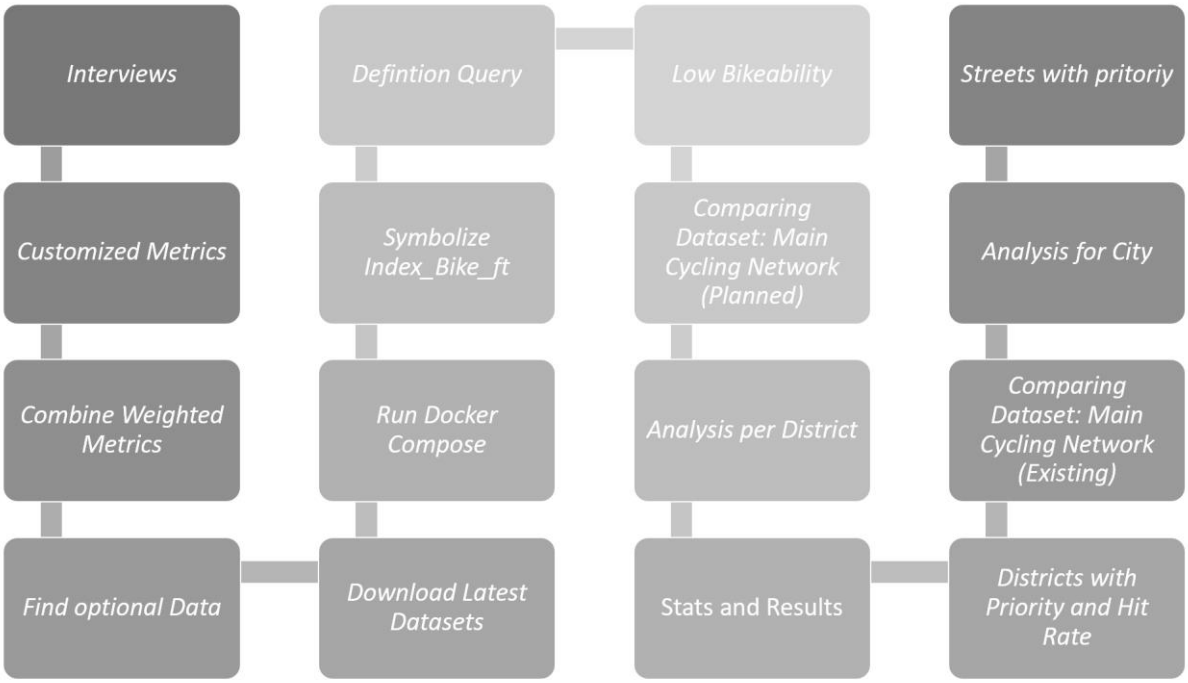

Figure 7: Schematic overview of Spatial Analysis Process

In figure 7 there is a schematic workflow of the spatial analysis. The detailed assessment is conducted in chapter 8. Generally, the interviews helped customize metrics and calculate the index. Optional datasets (OSM data: buildings and crossings) were included besides the GIP dataset (links and notes/street segments), more details on the used data, see chapter 8.1. After running the index tool, the street network was loaded into *ArcGIS Pro* to visualize, symbolize and select subsets. Low bikeability was pictured and compared with the dataset of the city. An analysis was conducted that estimated a hit rate of the index per district as well as streets with high potential. The calculation is explained in chapter 8.3. Statistics show the results. A detailed analysis of each district can be found in the appendix. Another dataset (existing main cycle network) was later used to understand what streets are neither in planning, nor in the existing network but measured as low. A list of streets was conducted where these criteria applied. Further, maps of a city overview and selected districts were used to demonstrate the results.

3.4 Concept of Field evaluation

In addition to a quantitative spatial analysis, a qualitative validation of the results of the index in the field is helpful. This section describes a concept for a field evaluation. The practical application of the field evaluation was not conducted in this thesis due to time constraints. The concept described in this chapter and in more detail in chapter 8.5 can be used for further studies. The research question this section aims to answer is the following:

What aspects of bikeability can a field review-based analysis of a selected region of Vienna consider compared to the index-based analysis NetAScore?

Process:

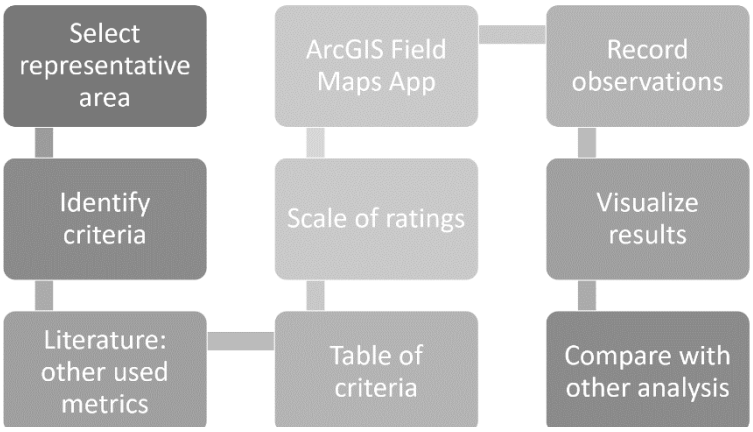

Figure 8: Schematic overview of a concept for a field evaluation

A representative area of Vienna must be selected. The evaluation should take place in selected street segments in the chosen area based on criteria identified from the reviewed literature and the suggestions by the experts. To know what criteria can be applied to Vienna a table with a list of previously used metrics in other qualitative reviews was created. A scale must be created to rate the metrics. The dataset of selected streets and used metrics can be uploaded to *ArcGIS* Field maps, an application for tablets and smartphones that is ideal for usage in the field. With this, the observations can be directly recorded and synchronized with the dataset. Next, the observations must be visualized on a map. Finally, the results from the field review can be compared to the index-based results.

3.5 Conduction on improvements

To answer the last research question, what improvements can be made based on previous findings, a list of suggestions will be conducted. The list can be seen as the summarized result of the practical part of this thesis and aims to give an overview of the main critics of the NetAScore index. A survey of the main problems and main findings during analysis can be found in chapter 8.4. The results of the analysis are stated in chapter 9 with the aim of concluding with productive feedback. A final table with both technical and practical feedback is listed in chapter 9.

4 The concept of bikeability

This chapter introduces the most important terms in the field of bikeability research and gives an overview of previous indices as well as the measurements of how the built environment can be assessed to fit the needs of cyclists.

4.1 Definitions

Bikeability

As the Scopus review in chapter 2 showed, the term bikeability is a relatively novel one, used in scientific papers only since 2005. The term cannot be found in dictionaries yet (Schmid-Querg et al., 2021). The term is not included in the Oxford dictionary nor elsewhere (as of April 2023). The most related term is *bikeable*. This term is defined as *suitable or fit for biking* or *suitable or safe for cycling* (Merriam Webster, 20.04.2023).

The term bikeability grew out of the research of walkability, the terms are often used similarly, but they differ. Infrastructure plays a more important role with bikeability, land use has more effects on walkability. They have different speeds, meaning cyclists cover longer distances thus there is more potential for safety risks. Bikeability can be defined as the extent to which the physical and perceived environment is suitable and safe for riding a bike. Bikeability comprises comfort, compatibility, suitability, friendliness and accessibility for biking. Since all of these terms again vary in their meaning, there is no universal definition (Kellstedt et al., 2021).

There are several approaches to find one definition. Different authors came up with explanations:

Krenn et al., 2015 defined bikeability as the assessment of comfort and safety for biking. Lowry et al., 2012 defined it as the ability to reach destinations and that bikeability is an assessment of a bikeway-network in terms of accessibility and the comfort (Grigore et al., 2019). Loidl et al., 2018 describe bikeability as the quality of road space for cyclists.

According to Martin Loidl, the initiator of the NetAScore toolbox, the spatial extent of bikeability is the axis of a street network. When bikeability is mentioned in the context

of the NetAScore toolbox, the evaluation and quantification of each street segment with a number from 0 to 1 is meant. This is called a segment-based index which only considers the segment and its value itself, not within a network (network analysis).

In this thesis the term bikeability will be used to define the quality each road segment has for a cyclist. Each street segment will be analyzed separately meaning that no overall bikeability score for the whole street network will be calculated. One segment also doesn't influence the measurement of another segment. Each segment is considered individually.

Cyclists have different needs, activity levels and are influenced by social demographic variables. In this thesis different cyclists' profiles or user types will not be considered. This would be beyond the scale of this work. For analyzing conditions in the study area, we make assumptions on the "general cyclist needs". Thus, a street segment that is high in bikeability is of good quality according to the general needs and according to the weights of the metrics the experts decided to assign.

Bicycle suitability

Lowry et al., 2012 described the three terms: bikeability, bicycle suitability and bicycle friendliness in this context. Bicycle suitability means the quality of linear bikeways considering safety and comfort issues.

Bicycle friendliness

Bicycle friendliness describes the evaluation of a whole community for aspects of bicycle travel (bikeability, policies and general approval of the population to cycling). Thus, a bicycle friendly neighborhood does not automatically have a high bikeability if it does not lead to important destinations (Lowry et al., 2012).

As described above, the three levels can be distinguished:

a. street is suitable for biking (bicycle suitability)

b. a neighborhood or city is bikeable (bikeability)

c. a community is bike friendly (bicycle friendliness)

When considering this definition concept, this thesis addresses bicycle suitability because the used index rates the quality of linear bikeways not the destination accessibility. Still, the term bikeability will be used differently in this thesis. The NetAScore toolbox for sustainable mobility can be defined as the analysis of an entire network of bike paths according to its suitability meaning the term bikeability and bicycle suitability are both appropriate. When measuring bikeability with the NetAScore toolbox certain attributes are valued numerically. These numbers are calculated together and the result is a value for each street segment and can be rated from not suitable for biking to highly suitable. Depending on the choice of attributes, its weighting and its final calculation different results appear (Lowry et al., 2012). NetAScore also calculated the facilities within reach of the line segment (within a 30 buffer) which can be seen as a measure of bikeability because destination density and points of interest are considered.

Bikeability index (BI)

This describes one method of bikeability measurements. The bikeability index and the bicycle level of service measure are most used in recent publications. The bikeability index evaluates an entire street network according to its built environment for a convenient cycling experience (Arellana et al., 2020). In this thesis the term (bikeability) index will be used to describe the quantitative method of calculating a value between 0 and 1 to define the amount of bikeability of one street. A good or high bikeability index means a high number and therefore high quality of the infrastructure for cyclists.

Street View Imagery (SVI)

Street View Imagery is imagery collected by cameras by cars driving on streets. The most known provider with easy access and worldwide coverage is Google Street View. The images taken are 360 degrees and the result is a vision of the surroundings as you would drive yourself. This creates a realistic imagery (Biljecki and Ito, 2021; Ito and Biljecki, 2021). Biljecki and Ito, 2021 conducted an extensive examination of over 600 papers, aiming to show the current utilization of street-level imagery in studies related to the built environment. The main findings show that street view imagery has become a well-established and integral aspect of urban analytics. Research heavily depends on data from Google Street View. Gullon et al., 2015 tested SVI and compared results to a walkability and bikeability index tool called M-SPACES (Madrid

Systematic Pedestrian and Cycling Environment Scan). Most analyzed streets showed little difference in virtual and physical audits. SVI can be used to support quantitative measurements of the built environment. In this thesis SVI supported the assessment study by comparing results of the index with imagery by Google.

Filtered permeability

The term filtered permeability was introduced by Steve Melia and describes the separation of non motorized traffic and motorized traffic to allow higher speed and less stress for cyclists or pedestrians. Melia, 2012 examined that most city planners follow a strategy of unfiltered permeability and allow all transport modes equal permeability which can be seen as the traditional street layout in the western countries.

4.2 Indices as spatial evaluation tools

A bikeability index (BI) evaluates the built environment. An indicator-based assessment (BI) is created by identifying indicators on the street that are contributing to the cyclist's safety. To understand at which locations and to what extent a lack of quality of the built environment exists, the first step is to quantify the components of the index. Therefore, individual aspects such as the number of lanes per street, speed zones, traffic volumes or intersections are being quantified and summed up to understand the influence of each aspect on the bikeability of a street. The result with the lowest score is a segment with low bikeability. Depending on what importance the aspects are given, the result varies. This is referred to as the *weighting of metrics* in this thesis. Conventional methods like experts' assessment in the field, accident analysis or volunteered user feedback can be used to validate the index method afterwards. Methods used for validation of the NetAScore toolbox are listed in chapter 3. The result of an index applied to a study area can be used as a model to test different planning phases of the city by testing how they contribute to the bikeability. The result of the index can be the basis for routing application so that bikers only get suggested safe routes (Loidl and Zagel, 2015).

Data on route choice of cyclists can add important information. For example, depending on how often one road segment is being "used" it can determine how suitable and how important it is for a high bikeable path. Though, high bikeability is not the only relevant factor for choosing a route. Travel time may sometimes be more

important than the bikeability of a route. This is relevant for routing applications that are specialized in bike trips. Those applications need options like the fastest route and safest route for selection to the user. Since bikeability indices only measure one aspect, the quality of infrastructure for cycling, this is a shortcoming of bikeability indices in general. If a routing application was based on the results of a bikeability index it is most likely that users would take detours to get to their destinations.

Another factor besides measuring the quality of each segment can be considering the amount of detours a good trip (high in bikeability) demands (Gholamialam and Matisziw, 2019). You could measure how often, given a set of origins and destinations, the bike route would differ from the vehicle route. A study by Gholamialam and Matisziw, 2019 found out that on average trips tend to be 1 mile longer than the shortest path. When limiting the data to trips shorter then 2 miles (which in fact are the most taken trips) the average route is 0.3 miles longer. Another study mentioned in the paper of Buehler et al., 2015 even stated that commuters are willing to take an extra 20 minutes of their trip if this means they can ride on separate bike paths.

Recent work has opened a new field where virtual audits via street view imagery and computer vision help analyzing conditions on the streets for evaluation of bikeability. This can help but not replace manual visual inspection of streets (Ito and Biljecki, 2021).

4.3 Existing indices

Most evaluation methods of bikeability involve assessing various street attributes and assigning numerical scores to each attribute, which are then combined to form a total score. Examples are the bicycle level of service (BLOS) or the Level of Traffic Stress (see chapter 2.3).

However, these methods are not developed based on route choice studies. Grigore et al., 2019 suggested a more appropriate method: comparing GPS traces of cyclists' actual routes with the shortest possible routes. The authors call this the most suitable method to calculate bikeability.

However, this thesis focusses on the NetAScore toolbox and the used bikeability index. In this chapter other relevant BI are listed that are comparable to the NetAScore toolbox. This aims to understand how comparable indices are calculated, used and

tested. Kellstedt et al., 2021 published a paper where they reviewed 17 studies regarding instruments to measure bikeability and compared the used tools. This paper was the basis of the following selected BIs. Chapter 2.3 explains the classification of the used literature. Some of the classified papers are analyzed in more detail and listed in this chapter.

ACRES Scale

The name stands for active community route environment scale. It was created for research in Stockholm in 2010 with the aim of assessing the bicyclists and pedestrians' perception of commuting and the environment. Commuters and experts had to fill out 18 indicators (both physical, traffic and social aspects) and their perception of these criteria along a route. The ACRES scale proved its validity for assessing cyclists perception of urban environments though it is intended to be used by professionals (Wahlgren et al., 2010).

BikeScore®

This score was introduced as a bikeability index by Winters et al., 2013 and Winters et al., 2016. It was branded and is a private company with a protected name. It is available for 160 cities in the US and Canada. By providing the zip code of a city, the BikeScore tool calculates the result by using a bike lane score, a hill score and a destinations and connectivity score. Data is used from USGS, OSM and the US Census. The methodology is described verbally online with a step-by-step guide. The limitation the authors named is that the index can not be used on other areas. Their BikeScore might also not be able to detect small but maybe important changes in infrastructure since it is not sensitive enough. Still, the tool Winters et al. invented can be used to support the

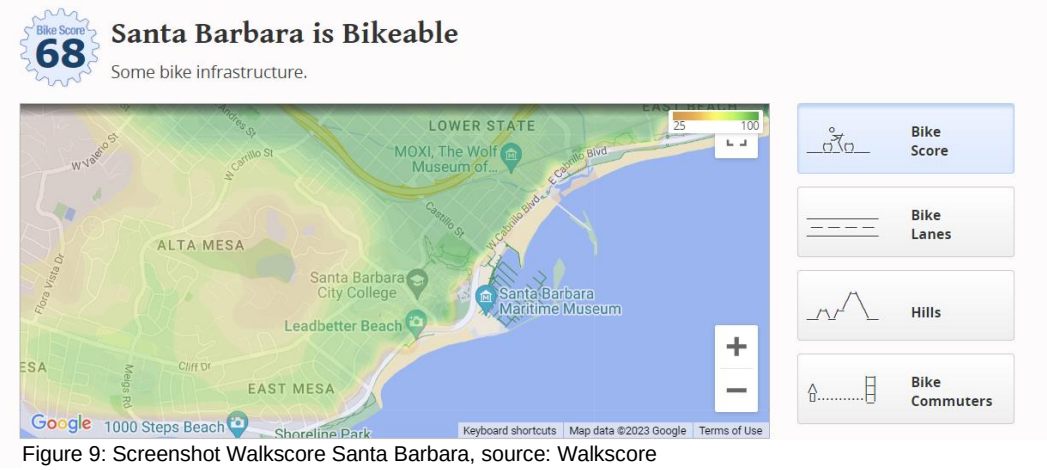

Figure 9: Screenshot Walkscore Santa Barbara, source: Walkscore

planning processes and is easy to use and easily available for everyone. Figure 9 shows the result when typing *Santa Barbara* into the search field. The tool is available at: https://www.walkscore.com/.

To evaluate the validity of the tool, Winters et al., 2016 analyzed the correlation between the values of the BikeScore and work-related trips. They found a correlation between the share of travel to work mode and BikeScore, meaning a higher BikeScore is associated with more people using the bike to travel to work. They even made the prediction that a 10 unit increase in BikeScore relates to a 0.5% increase in journeys by bike. This was conducted in 24 cities where biking rates were already quite high (student cities) meaning this may have influenced the results.

BiWET

Hoedl et al., 2010 analyzed the city of Graz in 2007 with the Bikeability and Walkability Evaluation Table (BiWET). Experienced bikers were asked to cycle at a certain speed and evaluate the following aspects based on 10m street segments: safety, attractiveness, land use and walking and cycling infrastructure.

M-SPACES

The Madrid Systematic Pedestrian and Cycling Environment Scale was used to audit streets virtually and physically. Aspects like function, safety, aesthetics and destinations each consisting of more elements were identified. The audit tool was originally developed to observe cycling and walking attributes along streets. In the study by Gullon et al., 2015 the tool was evaluated by using Google Street view. Results showed that there is high correlation between the results meaning virtual auditing is a valid method to rate urban areas.

MAPS-Global

The Microscale Audit of Pedestrian Streetscapes observes street elements regarding active mobility. The tool was tested by Cain et al., 2018 by experts in 5 countries. Elements like destinations, land use, streetscapes, street crossings, dead-ends and aesthetics comprise the result. The findings show that observers who received proper training could consistently perform observations of areas using the MAPS-Global tool.

The aim is to gather more practical experience using MAPS-Global for both research purposes and practical applications on an international scale.

Boettge et al., 2017 analyzed active cyclists' trips in St. Louis, USA and found that level of stress correlated with speed of cars as well as the width of the street and the number of lanes. The paper highlighted routes where cyclists experience high levels of stress.

Winters et al., 2010 analyzed bikeability in the city of Vancouver by mapping different aspects of bikeability measured on a 10m grid. After this study conducted in 2010, Winter et al. developed the previously mentioned BikeScore. In the first study, the first version of the index was calculated with the following metrics: bicycle facilities and their quality, the connectivity of streets, topography and land use of surroundings. The goal was to build a tool for planning purposes. Bikeability was mapped as a continuous surface given values from 1 to 10 to depict the measured bikeability. The authors used an opinion survey, travel behavior analysis and focus groups to get to their results. The analysis was meant to be easy and well documented so others can repeat.

Figure 10 shows the results of measured bikeability in the city of Vancouver by Winters et al., 2013 A continuous surface was created to eliminate the modifiable areal unit problem.

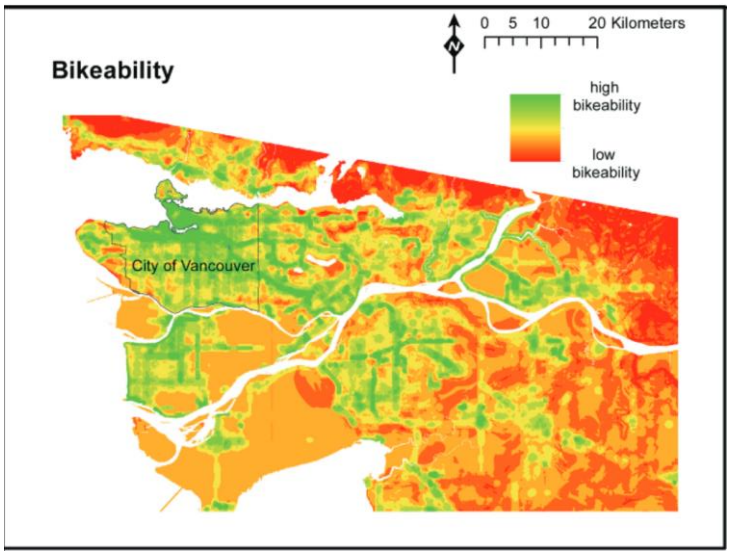

Figure 10: Bikeability Vancouver, source: Winters et al., 2013, p.874

The modifiable areal unit problem otherwise determines the result of analysis depending on the boundaries chosen. This is a limitation of indices. Further, the results

remain to be location specific (also the components that they found out to be important in that area) and cannot be directly applied to another use case without adaptation.

Hardinghaus et al., 2021 analyzed Berlin and its bikeability. 140 experts were given a survey to weigh the metrics for the index. The parameters were then calculated based on OSM data. To understand the validity of the index, a mode choice model was calculated based on travel survey data. To understand if there is a correlation between traveled route and measured bikeability. The results showed that the measured bikeability of streets has significant influence on the mode choice of actual trips. The bikeability index developed in that paper showed good performance for that area. This also means that using OSM data showed good enough result for representing bikeability, at least measured for this area.

Walkability

Sallis et al., 2016 conducted a study in 14 cities worldwide concerning how urban environments influence the physical activity of pedestrians. Results show that residential density, intersection density, the amount of PT and green areas are correlating with the activity of people. The design of urban environments therefore can influence public health. This was measured with almost 14,000 participants wearing accelerometers for 7 days. This suggests that similar results can be observed for cyclists.

Route Choice

When analyzing route choices Winters et al., 2013 found out that for both cyclists and car users, the actual trip distance was longer than the shortest route. Measured for the area of Vancouver, cycle trips were on average 360 m longer (11%) than their respective shortest route. The actual used routes had more traffic calming features, lower air pollution and less hills. To sum up, the built environment and the individual perception of safety are influencing the route choice resulting in longer trips. Based on a survey with 140 participants Winters et al., 2010 found out that cyclists detour directly towards infrastructure, which is even more supporting the results.

Krenn et al., 2015 made similar discoveries in Graz, Austria. They examined bicycle trips for the development of a bikeability index. The index was calculated for 100m squared raster cells and mapped accordingly. For validating the index, they analyzed

what factors were relevant when cyclists chose their route by comparing the actual taken route (278 cycling trips were recorded a GPS logger) with the shortest route. Actual taken trips were longer than the shortest route and cyclists in Graz tend to use designated infrastructure, flat areas and green surroundings.

Route choice analysis with empirical data gathered by students in Trondheim was examined in the study of Pritchard et al., 2019. They tested the BLOS method and results showed that when cyclists detour around 15 to 20% of length, they achieve the highest level of BLOS measurements. Based on this research area and type of cyclist (student) the assumption can be made that only if you take a longer route and detour from the shortest route you achieve a good cycling experience.

4.4 Limitations of indices

A few problems that occurred in the mentioned literature while conducting bikeability and walkability results are described in this chapter. A more detailed explanation of limitations can be found in chapter 9.2.

A problem that occurs in all models of bikeability is the dependency of good source data for evaluating a network. The result of the index hardly depends on the quality of the input data (Buehler and Dill, 2016). The most accurate data that best depicts the actual usage of streets by cyclists would be geospatial data of cyclists' volumes or trips taken. This data is not available for the city of Vienna.

A global model cannot have accurate results everywhere. Models cannot depict reality and don't aim to do so. Still, research is necessary to further improve bikeability tools and models (Loidl and Zagel, 2015).

Generally, the lack of standardization in bikeability tools and measurement methods is a limitation. For being able to compare index results within different areas data sources like OSM or other widely and freely available data is crucial. The use of SVI also enables wide usage of an index. The trend in literature can be observed that with more studies using these new methods, studies become more standardized. Subjective metrics get less attention in more recent studies because they take up more effort when collecting and are hard to compare (Ito and Biljecki, 2021).

If accidents are analyzed and bikeability is derived from this, the problem occurs that segments that are highly frequented tend to have higher accident rates just because more people are cycling. Though highly frequented streets maybe have good infrastructure. A correlation between accidents and bikeability is therefore not easy to derive. Methods that evaluate the built environment are generally is more sophisticated and should be used (Loidl and Zagel, 2015).

To determine the road network quality in terms of safety, expert assessments are an option. These have limitations like the subjective perspective of the expert. Therefore, a universal evaluation (a catalogue of features) would be helpful. Results are hard to compare when described verbally. The knowledge of experts is still an important approach. In this thesis experts will be assigned to rate metrics for the use case area as well as provide further local knowledge.

There is a measured inconsistency concerning usage of main roads or bicycle lanes. Some studies found out that main roads are more often used than bike lanes meaning that if you evaluate a street network using an index, you must evaluate the bikeability of main roads higher or at least as high as the bike lanes (Int Panis et al., 2011; Winters et al., 2010). This inconsistency could be because street networks are different in every country, also the availability of bike infrastructure may vary depending on the study area. This is one shortcoming of bikeability indices in general. Every city has its own characteristics that should be considered when measuring bikeability. This can be done best by adjusting the weights of the index, if possible. To do so, you must know local conditions. Otherwise the result of the index may not be accurate (Krenn et al., 2014).

4.5 Metrics for bikeability

As mentioned before, the built environment determines the behavior of cyclists. The built environment in cities can be understood as all physical components in an urban area and the patterns of human activity within that environment. According to Arellana et al., 2020 it can be described using the 5D's – density, diversity, design, destinations (accessibility) and distance (to transit). To assess these attributes from a cyclist perspective, as mentioned before, a BI can be used. BI describe the bicycle as a form of transport by evaluating the entire street network.

Generally, there is little consistency in the metrics used for calculation and their correlation with bikeability values because theory and methods of measuring the environment for cyclists are not connected and data limitations occur. Further, there is no universal way of calculating bikeability nor standardized definitions of its metrics. Thus, methods and results are hardly comparable (Muhs and Clifton, 2016).

This chapter aims to summarize all metrics that were used in previous studies and categorize them for overviewing all aspects of a bikeability result. Evaluating the built environment is only one metric out of many used to determine the bikeability of a street. The term *metrics* for bikeability is used in this thesis to describe all factors of influence that are comprised to conduct the bikeability of a street.

The NetAScore index uses some of the listed metrics. This is described in detail in chapter 6.5.

Metrics of influence can be categorized into the following meta categories:

- **Hard factors of influence**: all aspects concerning the built environment, facilities and infrastructure.
- **Soft factors of influence**: aspects like policies, education and social issues.
- **Objective factors**: objectively recorded with methods like SVI, GIS analysis or statistical methods. Generally, quantitative methods are used here.
- **Subjective factors:** self-reported with methods like observations, perception of an area, audit tools, interviews or surveys and questionnaires. Generally, qualitative methods collect subjective factors.
- **Macro scale** and **Micro scale** variables: Macro scale variables measure the environment within an area, for example the destination density, population density, or the land use. Micro scale variables analyze road conditions like the surface, intersections or bike paths. Bikeability studies mostly use micro scale variables.

Titze et al. explained that not only the built environment influences cycling as a means of transport. Both factors classified as political or psychosocial influence cyclists' behavior (see figure 11).

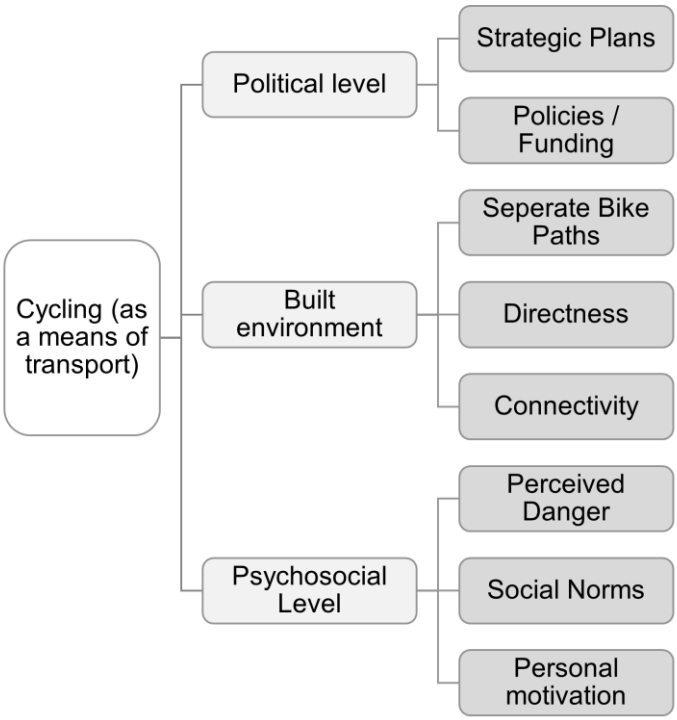

Figure 11: Influential factors for cycling, source: based on Titze et al., 2010, p.44

Political will and resulting funding for cycling is the base to increase cycling rates. Psychosocial reasons like personal attitude, self-confidence, behavioral control, persistence, self-efficacy, lack of time and interest in cycling can be named here. Many of these associations linked to cycling have been influencial by information campaigns and are seen as low-cost intervention options (Titze et al., 2010). Social norms and role models were consistently positively associated with cycling as a means of transport. Strengthening social support is therefore seen as an effective measure to increase cycling. Many natural conditions such as climate, topography and weather have an influence on the use of the bicycle as a means of transport. However, these variables cannot be changed by interventions. Other conditions such as attractive surroundings, direct routes, safe bicycle parking, short distances to shops and bicycle parking at the workplace are positively related to cycling and can be influenced (Titze et al., 2010). A comprehensive cycling network with an attractive infrastructure for cycling and parking bicycles is an essential building block for the systematic promotion of cycling. These include a motivating communication and information strategy and

service offerings to improve the attractiveness and facilitate the use of bicycles (Meschik, 2008). The built environment as referred to before, can be analyzed using the following metrics (figure 12). Those were derived from literature. The literature list can be found in the appendix (chapter 11.5).

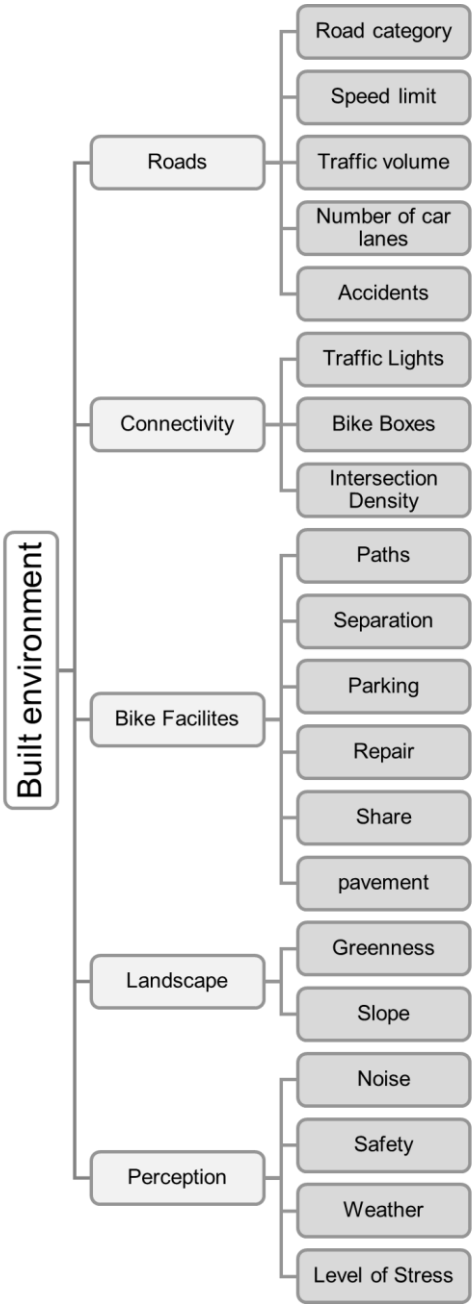

Figure 12: Factors that describe the built environment

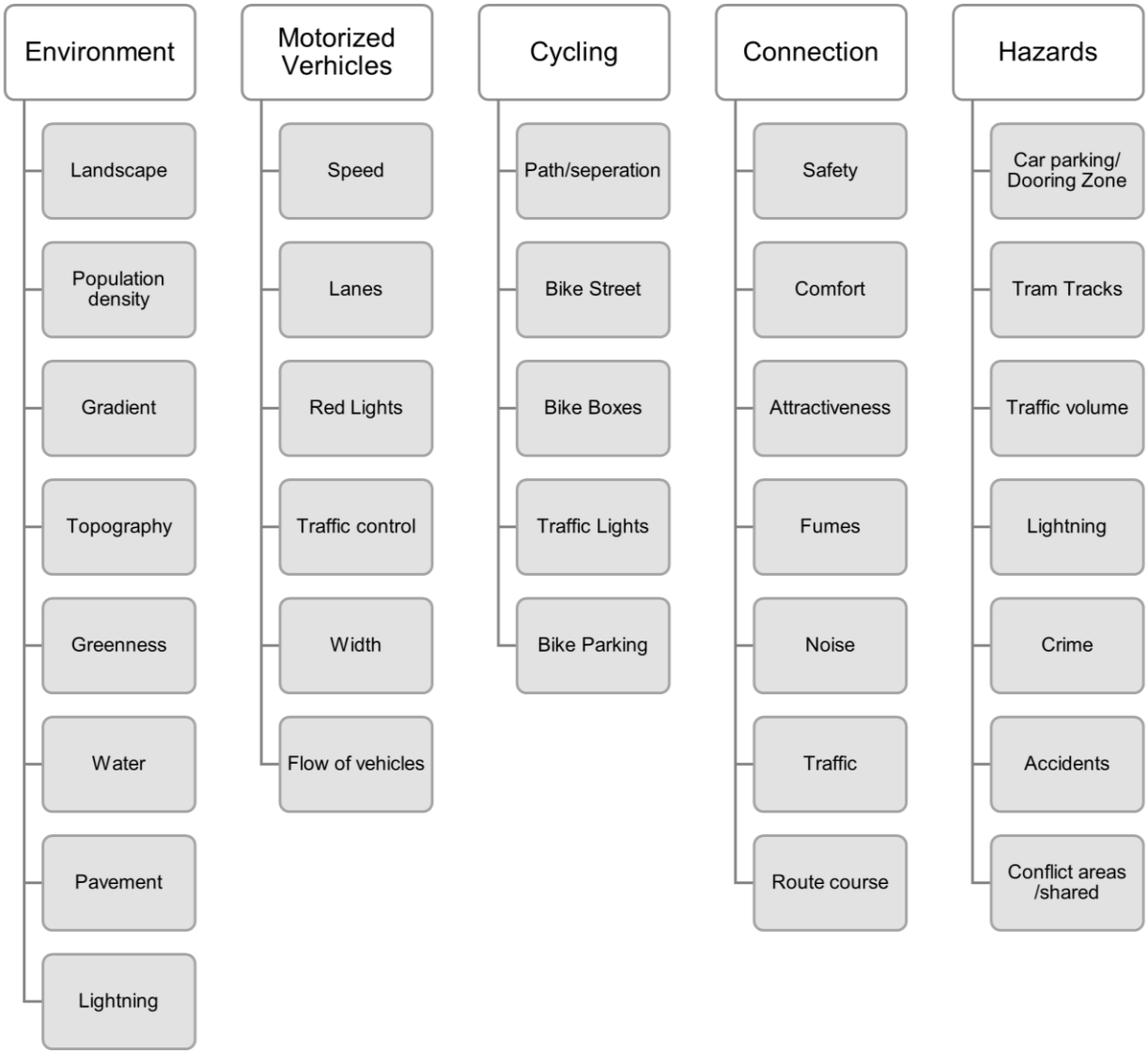

Figure 13: Overview of all factors that influence bikeability

A more detailed overview is depicted in figure 13. This comprises not only built environment attributes but also subjective factors (safety, attractiveness). These factors all influence bike behavior.

The perception of danger is the main deterrent for people not to cycle, Kellstedt et al., 2021 found out. Features that improve safety and minimize danger are separate bike lanes, traffic calming features and tighter enforcement of traffic laws.

High levels of stress for bikers arise because of a high speed limit of cars and no adequate separation as well as dangerous situations at intersections and poor visibility (Gholamialam and Matisziw, 2019). The subjectively perceived risk of injury while cycling has remained a sensitive issue to this day and, especially in countries where cycling is not very widespread, sometimes even hinders efforts to promote cycling. A

reduction in speed limits meaning an overall limit of 30 km/h in urban areas would be a first step towards minimizing danger and its perception (Titze et al., 2010).

According to findings in Graz from Krenn et al., 2015 bicycle pathways, bicycle lanes and flat terrain were preferred and traffic lights and crossings were avoided. This means for the index: it makes sense to consider bikeways in all their forms because they contribute to the feeling of high bikeability. The findings in Graz can not be directly compared to findings in the US or Canada because cities are differently structured, being more dense and smaller in area in Europe or in that case Austria.

Studies on route choices for cyclists show that routes with green areas, less crossing and a flat terrain are chosen even if this means taking detours. Furthermore, bikers tend to avoid traffic lights and waiting time (Krenn et al., 2015). Intersections are seen as the mostly avoided element on the street (within experienced cyclists). Their design is crucial for the safety of cyclists. The factor intersection is not often analyzed in bikeability studies (Schmid-Querg et al., 2021).

Kirchner, 2017 initiated the *GoGreen* project, to investigate the correlation between active mobility and greening for the promotion of walking and cycling. There is a close connection between street greening and active mobility. Thus, active mobility can be increased in the future if the quality and quantity of greening in street spaces is raised. In the conducted surveys, greening is given a high priority for three quarters of respondents. Greenery is together with traffic calming important on their daily routes. In a 30-40 m street cross-section, a person feels lost without a tree. In the case of wider streets, greening appears as a spacer from vehicular traffic. Subjectively, the feeling of a sound barrier is also conveyed. Shading is becoming an increasingly important factor that can contribute significantly to reducing heat exposure and thus make cycling more attractive.

Personal motivation has strong effects on mobility choices, a study that examined the survey *Österreich unterwegs* from 2014 states. Household characteristics, age, gender and financial situation have an impact on the choice of mobility (Ashrafi, 2017). Income correlates with possession of driver’s licenses and therefore resulting in car ownership although also age and lifestyle play a role. Men are more likely to use a car while women use PT more often. Higher education means both more car usage and higher usage of PT. The size of the household also plays a role, whilst more people in one

household increase car ownership. There are indications that women prefer cycling routes, whereas men, independently of the network of cycling routes, look for the most direct route (De Witte et al., 2013).

According to Meschik, 2008 depending on the reason for the trip, cycle infrastructure has different requirements.

Requirements for everyday routes

Conditions: weather-independent use, increased during peak traffic periods, time pressure

- high speed of travel (20-30 km/h)
- Overtaking opportunities
- dense network of infrastructure
- Interactions with other road should not hinder traffic flow
- High safety at intersections combined with simple guidance
- direct connection: detour sensitivity, slope sensitivity
- Child-friendly facility in the catchment area of schools, etc.

Requirements for leisure routes

Conditions: used outside peak hours, weather dependent, no time pressure

- high need for safety
- attractive surroundings
- no nuisance by other road users (stress, noise, etc.)
- child-friendly installation and protection at intersections
- Climbing aids

4.6 Bike network components

The most important metric for cyclists is the existence of bicycle infrastructure. The perceived and actual safety is much higher when riding on streets with adequate facilities. Still, there are many kinds of bicycle infrastructure and no universal definition exists that can be applied to every country. For example, the term bike lane can mean

a lot of different things from a painted lane with mixed use of cyclists and cars to a physically separated path. For the calculation of the index and the interpretation of the results this is highly relevant to understand. This chapter aims to give a general overview of used terms in scientific papers and its description. Further, a detailed distinction between used terms in Vienna's cycle planning is made.

Buehler and Dill, 2015 reviewed 67 peer reviewed studies to give an overview of the different elements that a bike network consists of. A general distinction between mixed traffic, bike facilities and intersections is made.

Shared roadways (mixed traffic)

Cyclists who ride on streets alongside with cars prefer fewer lanes and slower speed of cars (Buehler and Dill, 2016). This type of infrastructure should only be applied to streets with a speed limit below 30 km/h.

Bike Facilities: Lanes, Tracks, Paths

This can be bike lanes with markings on the streets, cycle tracks that are physically separated or bike paths that go through parks or are shared with walking. A study conducted in 42 US cities, found out that an additional mile of bike facilities contributes to a 1% in increase of bike commuters (Dill and Carr, 2003). Therefore, improving and extending all sorts of bike facilities is necessary to increase cycling rates.

Intersection Areas

Here, the potential conflict is higher, which means improving those areas and creating special rules and treatment for cyclists increases safety and perception of safety. Most accidents happen at intersections. Though, intersections can also be seen as a source of delay for cyclists. When stop signs or traffic lights regulate an intersection they tend to be avoided by cyclists. A separate signal phase which enables cyclists to have a head start or so-called bike boxes (areas where cyclists can wait and are better visible for cars) are options to improve intersection areas. Stop signs where bikers don't need to stop can improve the flow of commuting and limit travel time and detours for cyclists (Buehler and Dill, 2016).

Common infrastructure types in Vienna are sharrows (marking on the street) and multi use lanes. Mostly this means the street is shared with cars and cyclists must ride on

the right side of the street so that cars can overtake. Riding next to parking cars is dangerous for cyclists and should not be the common infrastructure. The so-called *dooring zone* means the zone where a car door can be opened and a cyclist may crash into the open door. This is a well-known and dangerous aspect (Boettge et al., 2017).

As the bikeability assessment is conducted in the city of Vienna, table 3 shows the distinction of all types of bike ways and their legal meaning used in Austria. The definitions are listed on the official website of the city of Vienna. The German term is necessary for clarification to talk about the same definition. All cycling infrastructure in Vienna is part of the main cycle network (dark grey in table 3). This is a freely available dataset. Generally, streets and bike ways can be distinguished. Bike ways are declared as such and mostly cyclists are obligated to use them. The terms marked with white in table 3 are all bike ways with different meanings. It needs to be said that the physically separated bike path only takes up about 10% of all bike ways in Vienna, even though it is proclaimed as being the safest. Multi use lanes were invented in the early 2000s and thought to be the solution for the arrangement of all modes of transport on the street. It turned out that this bike way type is unsecure and should be avoided. Bike streets are used more often in Vienna because they seem to work well. Those streets are completely open to cyclists, meaning cars are only allowed to cross this street. One example in Vienna is the newly planned Argentinierstraße which was planned according to a Dutch concept (expert interview 3). More information on this topic and more examples in Vienna are explained in chapter 7 and 8.

Table 3

Bike infrastructure terms in Austria – distinction

Term in this paper	German term	Short version	Legal meaning
Main cycle network	Hauptradverkehrs-netz	-	The official network for planners, grouped
Street	Radverkehrsanlage	RVA	All streets where biking is allowed
Bike way	Radfahranlagen	RFA	All declared bike ways as listed bellow (RVS in StVO and BmVO), cyclists are obligated to use them

Term in this paper	German term	Short version	Legal meaning
Bike path (one-way or two-way)	Radweg	RW	physically separated from traffic
Bike lane	Radfahrstreifen	RFS	Separated from traffic by a painted lane
Multi use lane	Mehrzweckstreifen	MZS	Separated from traffic by a painted lane that cars are allowed to use as well
Walk and Cycle Path	Geh- und Radweg	GRW	Mixed use for cyclists and pedestrians
One way for cyclists	Radfahren gegen Einbahn	RgE	A one-way street that cyclists are allowed to use in both directions
Traffic calmed	Verkehrsberuhigter Bereich	-	Area with low speed and mixed use
Cycling in pedestrian areas	Radfahren in Fußgängerzonen	-	Pedestrian area shared with cyclists
Bike Route	Radroute	-	Not necessarily a bike way but a declared route
Bike Street	Fahrradstraße	-	Street that is completely open for cyclists (priority over cars; max. speed cars: 30 km/h)
Bus lane	Busspur	-	Public Buses, Taxis and cyclists share the lane
Sharrow	Sharrow	-	A painted cyclist on the road, signalizes a MZS or RFS
Bikebox	Bikebox	-	A painted lane for cyclists to wait at red lights in front of cars

Note. Authors compilation and translation. Source: Anlagearten Wien, 16.06.2023.

There are differences in evaluating infrastructure because of different cycling levels. Experienced cyclists may prefer shared roadways over bike paths because they are faster and don't consider the safety component that much. Inexperienced cyclists have

a different perception of safety and may only take the bike if there are physically separated cycle tracks and other bike infrastructure. Depending on age, gender and social demographics there are different cyclists' profiles. An assessment of the bike network can never consider all these different aspects. Because this is a subjective matter the quantification is highly relevant because it sets a standard for safety and quality. Further research would be necessary to consider special needs of elderly people or children and level of experience (Buehler and Dill, 2016).

Due to the differences in speed and traffic behavior between pedestrians, bicycles and cars, these three modes of transport are only partially compatible and only partially to be driven on common traffic areas. In principle, different modes of transport must be separated from each other if there are large differences in speed. If there is not enough space for a properly separated cycle path, a speed limit (e.g. 30 km/h) can significantly improve the situation for cyclists. Separate routes for each mode of transport on their own facilities require significantly more space than mixed routes. Mixed traffic is therefore often the only alternative in inner-city districts and compact cities.

On the higher-level road network with a maximum permitted speed of more than 50 km/h, cycling and motor traffic must be separated. For medium traffic volumes and speeds between 30 km/h and 50 km/h, mixing or separating may be appropriate, whereas on the secondary road network low speeds should be pursued and mixed traffic should be preferred (Meschik, 2008).

Generally, 30 km/h speed limits all over the city are promoted by experts. As Heiner Monheim, geographer, urban planner and traffic experts already states in the Vienna Cycling Manifesto from 2013:

> "30 km/h zones have 100 % positive effects. By reducing car speeds, walking and cycling become faster since crossing-time losses disappear. Car drivers have become more cooperative. Perceived safety is enhanced. And actual safety is improved enormously by a 40-60% reduction in severe and fatal accidents. A general 30 km/h speed limit would be very beneficial." (Dvorak, 2013, p. 19)

5 Urban planning for bicycles

This chapter introduces international concepts regarding solutions for cycle planning. This should enable learning from other cities and experiences. Some concepts can be adapted and applied to Vienna, as experts say (expert interview 3).

5.1 International situation

This chapter lists some international best practice examples that have implemented traffic calming measures to improve the quality of living in cities.

In the Netherlands, there has been a fundamental shift of the transport infrastructure since the 1970s towards non motorized mobility. Today, the country is a pioneer when it comes to bicycle traffic expansion or protected intersections. There is a higher awareness of dealing with cyclists. Cars are generally slower, meaning interactions with cyclists are easier to handle.

An example from London: The so-called *Mini Hollands* concept was applied to London suburbs and changed their mobility structure using the Netherlands as an example. Car journeys that are less than 3 miles are targeted. Separate cycle paths, bicycle parking garages and cycle superhighways have been built as well as bicycle courses and 30 km/h speed limits have been introduced within that concept.

In Barcelona, the concept of *superblocks* is constantly being expanded. These are traffic-calmed areas that comprise blocks of houses to superblocks. The first block was built in 2017. Up to 9 city blocks can be combined to form one superblock where pedestrians and cyclists have priority over cars. Car lanes are being used for public spaces like playgrounds. Traffic is reduced, noise is minimized, and green/shady areas are built more frequently. This concept was mentioned by one of the experts interviewed for this master's thesis as a model for Vienna (Expert interview 3).

In Paris, there has been a sharp increase in the expansion of cycle paths for political reasons. By 2025, 70,000 parking spaces, meaning half of all parking spaces, aim to be repurposed. Repurposing existing infrastructures is an easy step to implement, especially in cities with an established structure.

Stockholm has introduced *summer roads*, roads that are open to cyclists in the summer months and limit car traffic. Furthermore, car-free Sundays are being implemented in 100 cities worldwide and are a measure to promote active mobility. Bogota, in Colombia, has a pioneering role here. The city hosts *Ciclovia*, car-free Sundays and public holidays.

In Berlin, there is the initiative of *Kiezblocks*, which follows the example of superblocks. The concept of *Kiezblocks* is of a participative structure where citizens can apply for their neighborhood to become car free. The initiative *Changing Cities* came up with this concept and there are already 65 of such blocks either active and in construction or already politically approved. The initiative aims to achieve 180 blocks. With the involvement of citizens there are great possibilities as this project shows. It also has high relevance for cycling numbers because measures that prevent car traffic flow support cyclists flows in return (Kiezblocks, 09.05.2023).

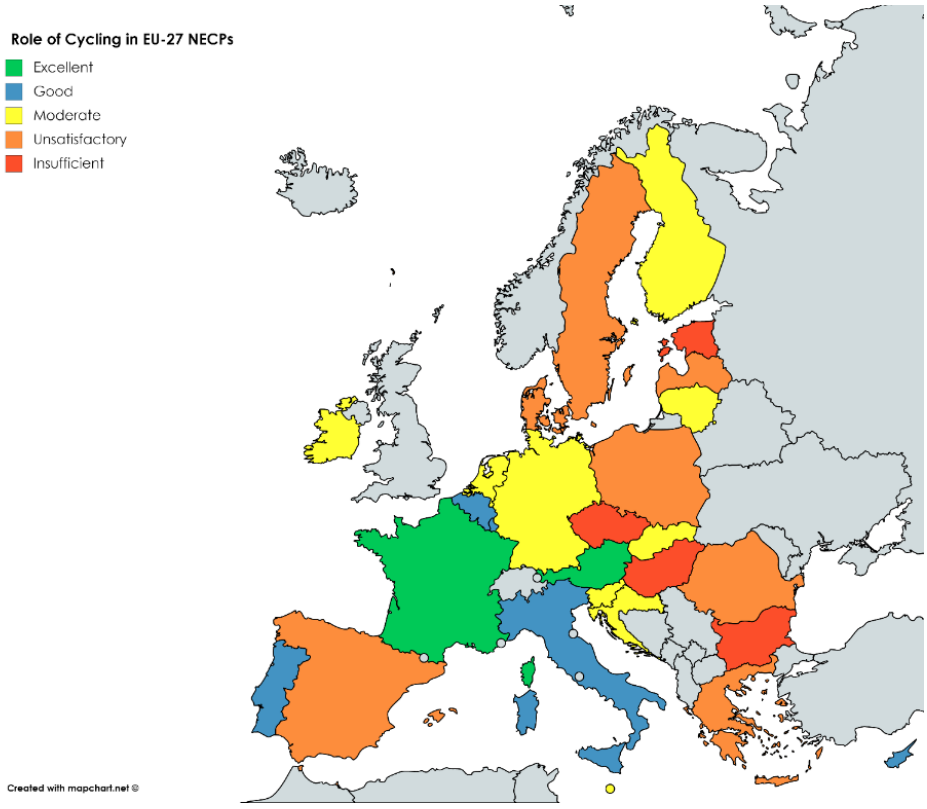

Figure 14: Role of Cycling in EU-27 NECPs, source: ECF NECPs

The ECF (European Cyclists Federation) analyzed the role of cycling in EU member states national energy and climate plans (NECPs) and came to the following result (see Figure 14).

ECF evaluated 27 drafts and final National Energy and Climate Plans (NECPs) for 2021-2030 to assess the role of cycling. The focus on cycling has improved since the first evaluation of 2018 with the final NECPs receiving a higher score in general.

France achieved the highest score by aiming to triple the share of cycling in transport, supported by a detailed plan. Austria and Belgium followed as top performers.

Portugal showed the most significant improvement because of the Portugal Cycling 2030 Program. Other notable climbers included Slovenia, Denmark, Ireland, and Luxembourg.

However, many member states still lack sufficient measures and funding to support cycling. Eleven countries that scored unsatisfactory failed to make significant progress. Moreover, Bulgaria and Hungary didn't mention cycling at all. It's worth noting that the attention given to cycling in NECPs does not fully align with certain other national policy frameworks, where cycling receives higher attention. Thus, this assessment does not provide an overall evaluation of EU countries' support for cycling.

The modal split is another more detailed method to describe the mobility behavior of the population. The modal split measurement, meaning the percentage share of each mode of transport, gives an even better understanding about local conditions and how active a city’s population is in mobility (Eurostat, 08.05.2023). Figure 15 shows the share of cyclists for capital cities in Europe.

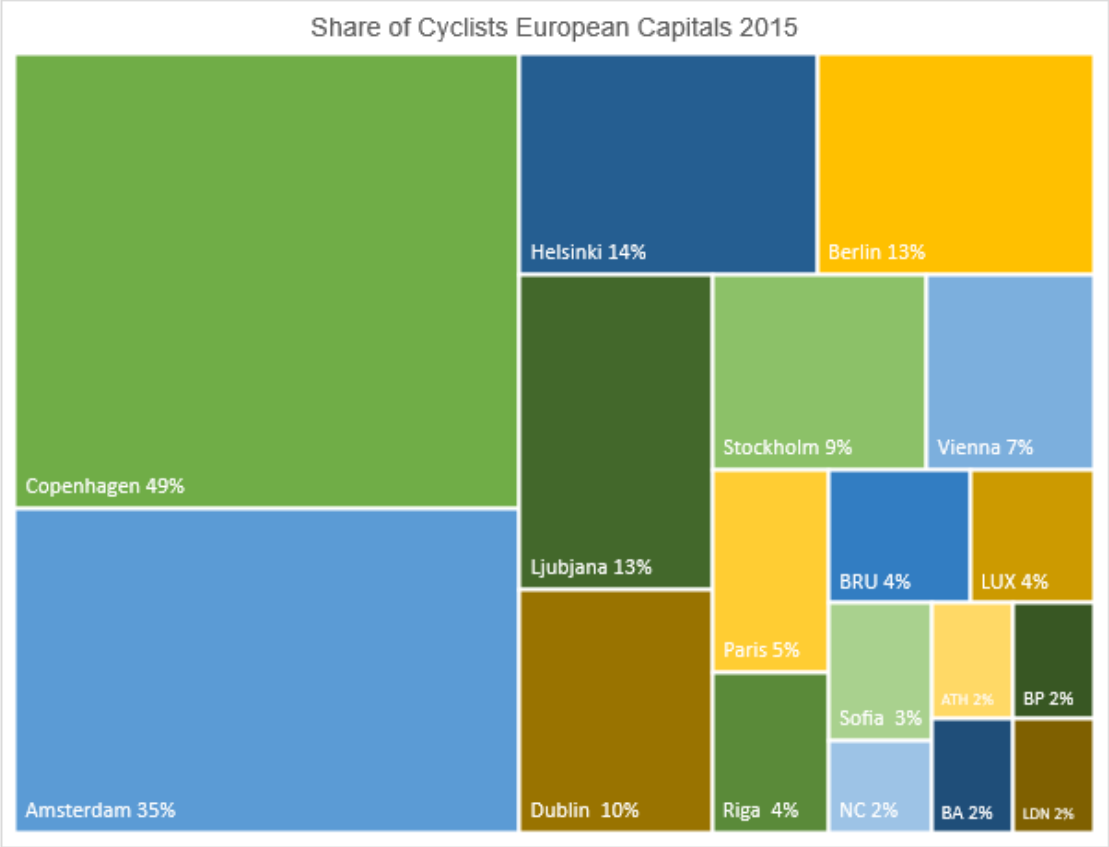

Figure 15: Share of Cyclists in European Capitals 2015, source: based on European Cyclist Federation

Numbers were derived from data from the ECF (timespan 2015-2018). Copenhagen is leading when it comes to cycling share with almost 50% followed by Amsterdam and Helsinki. Ljubljana has a high share of 13%. Vienna had a modal split of 7% cyclists in 2018. If a city is compact, meaning high population density and compact in space there is higher potential for active mobility. This might be a factor to consider when comparing cities. Today, the numbers have risen in Vienna. In Vienna the modal split is 35% pedestrians, 30% take PT and 26 % take the car and 9% are bikers (2022) as figure 16 shows (Fahrrad Wien, 05.05.2023).

Low numbers in Vienna can partly be explained by the high numbers of public transport users. This means those are mobility forms that are competing with each other because they are targeting the same population group (Wegener, 2017). If investments in PT in Vienna stay as high one can assume that numbers in biking will not increase a lot. Interestingly, the share of cyclists increased by 2% between 2020 and 2022, even though numbers were stagnating at 7% for a long time before. Effects of the Covid

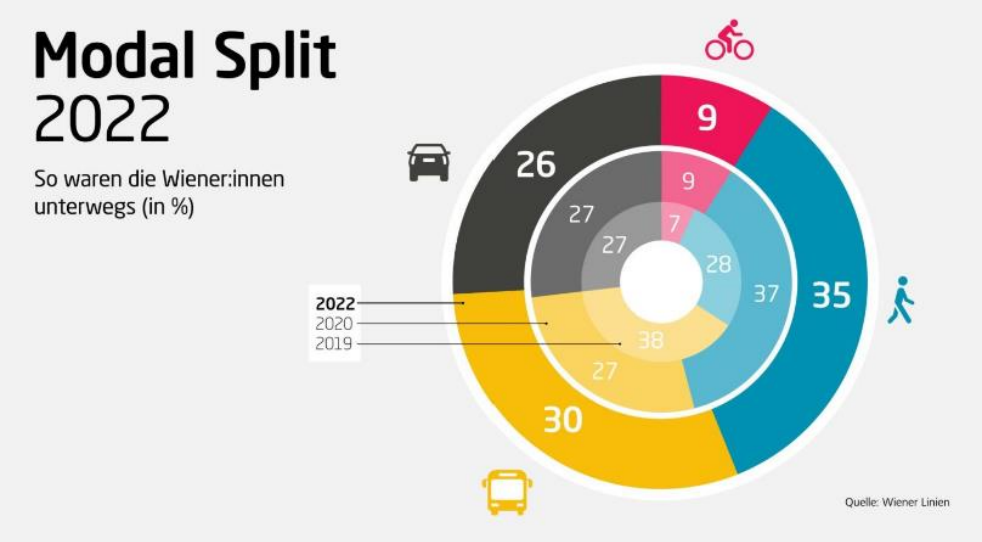

Figure 16: Modal Split Vienna 2022, source: Fahrrad Wien

Pandemic may have influence here. Still, just because this mode of transport is currently not chosen often does not mean investment is not needed. In fact, the planning of cycling infrastructure must be done in advance, to supply it before it is demanded by cyclists (RVS, 28.07.2023).

Another interesting statistic emphasizes the importance of fostering active mobility and PT in cities (figure 17). The space one person consumes while driving a car with a speed of 40 km/h is 60 m^2. A pedestrian only needs 0.8 m^2 and a bicycle only needs 3 m^2.

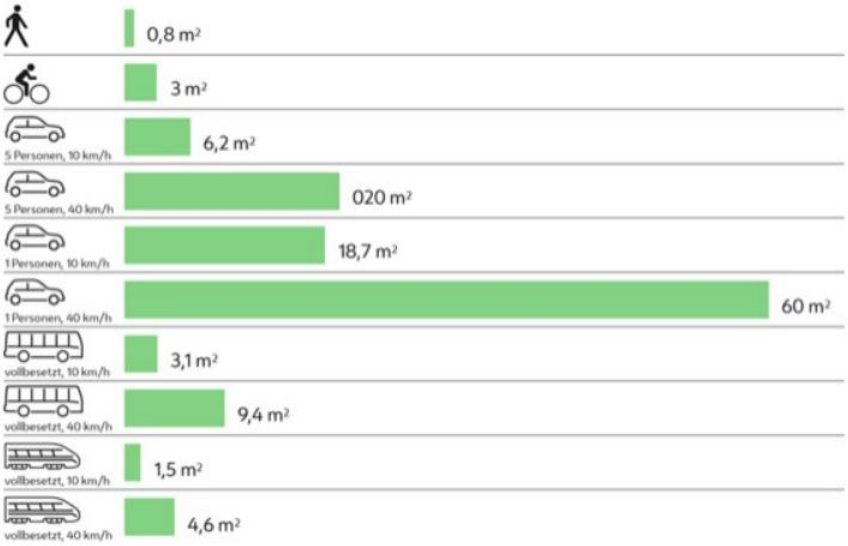

Figure 17: Space used by different modes of transport, source: Stadt Wien Stadtentwicklung

5.2 Benefits of biking for urban areas

Cycling ideally fulfils all 3 dimensions of sustainability (social, economic and environmental) and also has many benefits for health and accident prevention (Meschik, 2008).

Cycling has many positive impacts on the environment, social issues and on the health and physical well-being of cyclists themselves. In addition, both promotion and infrastructure for cycling are extremely cheap compared to motorized transport (Meschik, 2008).

Biking as a physical activity can easily be integrated in daily life and commuting because it is a moderate physical activity. The strongest evidence is available for the improvement of cardiovascular performance by cycling in everyday life. More than three quarters of the population owns a bicycle, promoting cycling as a means of transport is therefore an appropriate public health measure (Titze et al., 2010).

Cycling as a means of transport is a form of physical activity that can be carried out daily without excessive expenditure of time. It is noteworthy that cycling is suitable for all ages and for people of all social strata and all body weights. Nevertheless, there are subjective inhibitions to cycling. In many European countries, the benefits and disadvantages are perceived in a similar way by the public, but the frequency of cycling varies greatly from one country to another. This indicates that there are influencing factors that promote or hinder the use of the bicycle for transport purposes.

Accordingly, cities need to be planned, built and redesigned in such a way that it is possible for all people, regardless of their age or experience, to ride a bike safely. Cities should not only be transit zones, but places to live. They must be seen as systems designed to improve the quality of life and residence. At the same time, a high proportion of bicycles in traffic is an essential prerequisite for a livable and attractive city (InnoRAD ADFC, 10.07.2023).

The assumption that cycling is dangerous, exhausting, antiquated and unsuitable for inner-city mobility can be refuted. The perceived time gained from inner-city driving is consumed by additional time needed for physical activity or is paid for by a shorter life expectancy. Subjective resentment against cycling, mainly because of the danger and

impairment caused by motorized traffic, must be reduced by correspondingly good conditions for cycling and accompanying policies (Meschik, 2008).

Cycling needs to be established in the minds of all stakeholders (politicians, interest groups, trade, health care, etc.) to achieve a "cycling-friendly climate". This can either be done by creating incentives to promote cycling (so-called 'pull' measures, for example financial incentives) or by restrictions on competing modes of transport (so-called 'push measures', for example expensive car parking). Incentives alone are not enough since the bicycle competes with other means of transport for the available resources (space, money, priority, comfort, etc.). The allocation of resources is the responsibility of policy makers. This has the greatest benefit for the public (Meschik, 2008).

5.3 Digression: Copenhagenize – The Life-Sized City

Since Copenhagen is the leading city when it comes to cycling rates, this chapter goes into detail of a Danish concept for planning cities that fit everyone. Design principles as well as main points from the concept are described here.

The Danish Urban Planning and Design Company *Copenhagenize Design Co*. founded by Mikael Colville-Andersen published the book *The definitive guide to global bicycle urbanism* which explains why cycling is the future for city planning and what tools exist for making a city bicycle friendly based on the experience in Copenhagen. He demonstrates how to introduce the bicycle effectively and profitably as a respected, accepted, and feasible form of transportation. It is a guide to learn from the successes and failures of Copenhagen.

Road space must be reallocated for “best practice” bicycle infrastructure. This will have growing cycling numbers and soon cycling will be the mainstream mode of transport as claimed by Colville-Andersen.

Further, he explains that streets were democratic 7000 years ago since humans started living in cities. They were the public space for citizens where economic activity and social interactions took place. Until 100 years ago when automobiles were invented, and a paradigm shift hit the urban and suburban spaces. That’s when public space was reinvented as a space where cars can travel fluently in the least amount of time. Nowadays, cars no longer have a place in big cities of our time. A transition back to

the future is inevitably happening in the next decades, he states. Cities like Paris, Amsterdam, Oslo or Utrecht remove parking sports to make space for bikes, pedestrians and public spots where people can spend their time even when they are not commuting. Helsinki is mentioned as the future of urban development that needs to be closely watched in the next years. The author calls it *The Age of Urbanism* meaning nowadays is the age where we create the cities of tomorrow and where we rearrange public space in urban areas to fit everybody's needs. That's when the term *Life-Sized City* comes into play. Until now, engineers had to solve the question of how many cars can be moved down a street. According to Colville-Andersen, a different question needs to be asked: How many people can we move down a street? In fact,

Figure 18 shows how space can be redesigned to solve the latter question. With this design, 10 times more people can be transported, according to the Guide.

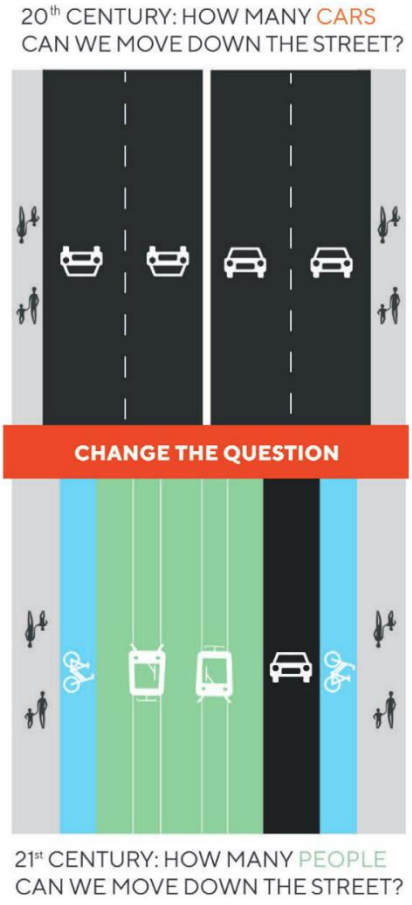

Figure 18: Space concept for street design, source: Colville-Andersen, 2018, p.198

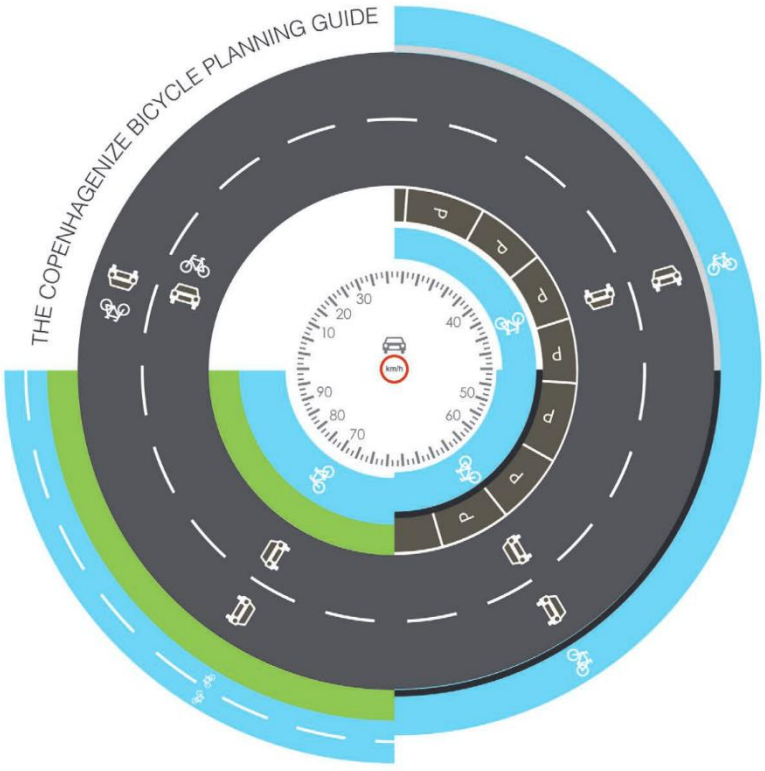

Figure 19: Concept for Bicycle planning, source: Colville-Andersen, 2018, p.177

The term *induced demand* is used to explain the phenomena that when you offer something people will adapt. If planners make more space for cars, more traffic will be the consequence. So, if you create a good quality bike infrastructure people will start

using it, according to the author. This goes hand in hand with the expert's opinion interviewed for this thesis. Planning cycle infrastructure is supply planning meaning it is planned in advance, before people start using it (Expert interview 1).

The design principle mentioned in the book is as simple as shown in Figure 19. There are 4 types of infrastructure planning. Depending on the speed limit and the amount of cars driving down a street one of the 4 design principles will be used. The author used this principle in every city that he advised so far. When the speed limit of cars is below 35 km/h the bike lane can be placed in the same lane as cars and no separate lane is necessary. If the speed limit is above 35 and below 45 km/h the bike lane must be placed beside the street with a parking lane in between. Above 45 km/h and until 65 km/h there needs to be some kind of separation in between bike lane and car lane. Above that a physical barrier that is as wide as the bike lane itself, for example a green barrier must be made.

Those principles can be found in Austrian regulations as well. In the RVS, a technical guide on traffic planning, similar concepts can be found (RVS, 28.07.2023).

Still, most bike lanes are not physically separated (see chapter 7.2). In Vienna the road network can be split into different categories depending on their relevance. Most of the main connecting roads still have a speed limit of 50 km/h. A 30 km/h limit for the whole city is being discussed also because other European cities function as a role model and show that it is possible. To this date, the *VCÖ* and some political parties and climate friendly institutions claim a 30 km/h limit would be the safest and best for the population and the climate. Still there are other strong political opinions that hinder this. In Paris, 85% of the city has a limit of 30 km/h. In fact, if you built infrastructure according to design principles as Colville-Andersen suggest, more people can be moved in a more efficient way. He shows an example that 5900 cyclists can move down a street per hour while at the same time only 800-1200 cars can move down a street per hour.

It is mentioned that for half of the people that cycle in Copenhagen, the main reason is that it is the fastest option. It can be concluded that, if a city makes biking the fastest option, then people will start using it because the benefits in time remain to be the most important factor for choosing the mode of transport, Colville-Andersen states.

The Copenhagenize Design Co. invented an online tool (the *Arrogance of Space Mapping Tool*) where you can easily calculate how much space different modes of transport take up for a selected areal image.

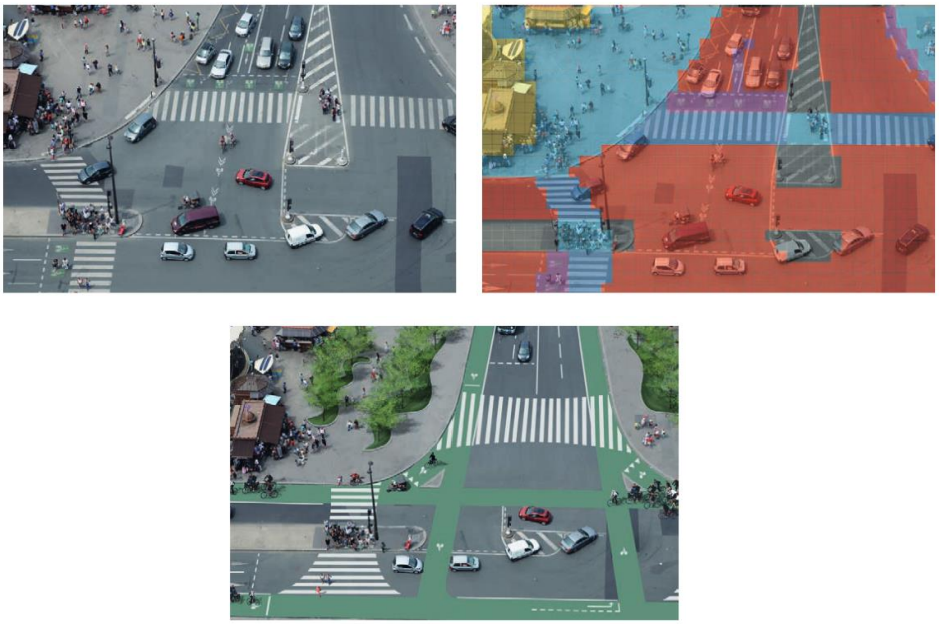

Figure 20: The Arrogance of Space Mapping Tool, source: Colville-Andersen, 2018, p.92

Figure 20 shows an example of a crossing in Paris where the space for cars is marked as red, pedestrians as blue and cyclists as purple. The road space is mostly used by cars on the left figure. The bottom figure shows how space can be reallocated so that bicycle infrastructure can be added to secure safe biking as well as car traffic. This is a quick and simple example of how space can be rearranged to fit other needs than the car. It has to be mentioned that every city has a different structure and Paris or Berlin have much wider streets than Vienna, so this concept cannot be applied to every intersection.

To compare Figure 20 with situations in Vienna, the following examples show places where this tool can be used efficiently.

Situation 1: Schottentor Crossing, 1010 Vienna.

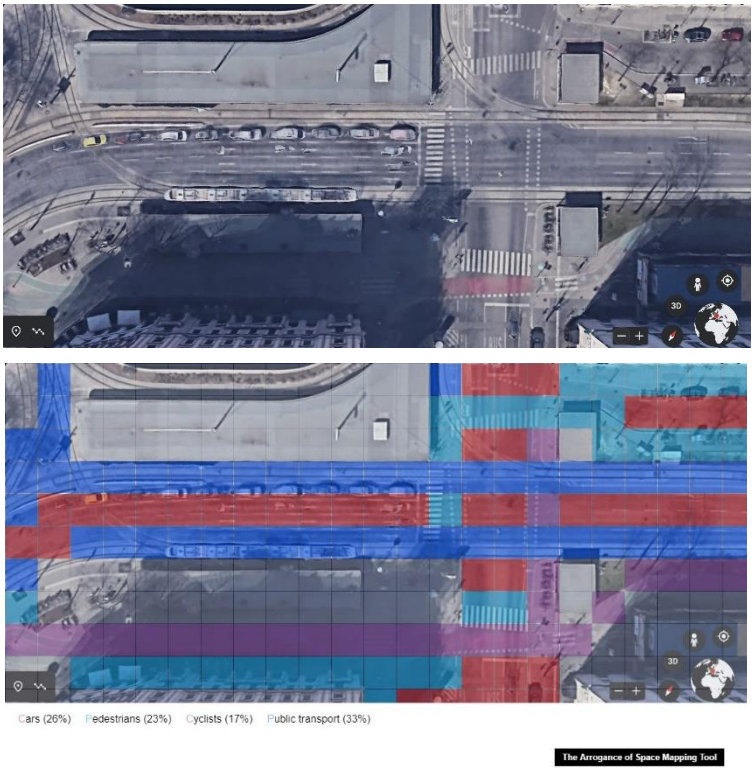

Figure 21: The Arrogance of Space Mapping Tool, Schottentor Vienna

As a visual example the crossing at Schottentor is analyzed with the tool (figure 21). Two major roads are crossing, each with 4 lanes for cars. 2 lanes of PT and one bike lane on each side. When comparing the size of the areas cyclists have the least amount of space (17%).

Situation 2: Lothringerstraße/ Stadtpark, 1010 Vienna.

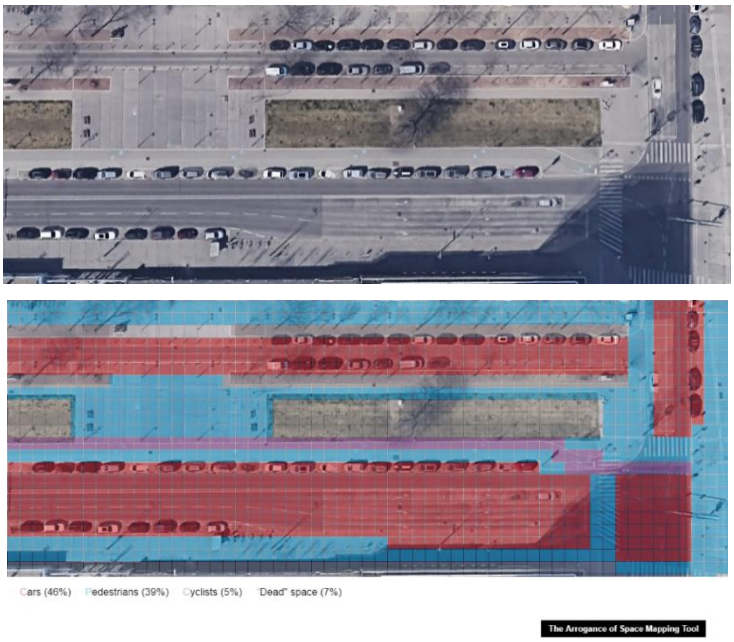

Figure 22: The Arrogance of Space Mapping Tool

Another example close to Stadtpark shows even more significant results (figure 22). With only one bike lane for both directions the ratio is 5% space for cyclists to 46 % space for cars.

These are really generalized calculations and only aim to visually show the importance of a fair distribution of space and the possibility that there is enough area to split it fairly for every mode of transport. The message for all transport issues in cities is the space argument. In growing cities neither electric cars nor autonomous cars can solve the space problem. Only the inclusion of all forms of transport and the equal sharing of public space with all forms of transport is a fair solution to the space problem and should be kept in mind. As Mikael Colville Andersen states in a publication for Greenpeace:

> “It is time to democratize the roads and redistribute the space. If we are serious about tackling climate change, the first step is to relieve our cities by a high percentage of cars.” (Greenpeace, 27.06.2023)

The cycling infrastructure must be consistently planned and implemented in a uniform manner so that traffic flows can be predictable and standardized. Interactions between cars and bicycles can then function as smoothly as possible. In bicycle traffic planning, both specialist knowledge and local knowledge are important to find suitable solutions.

6 NetAScore

The following chapters of this thesis describe the practical part including detailed information about the used index, the area of application as well as the assessment study itself. This chapter explains the functionalities of the NetAScore toolbox, its origin, the technical background, a schematic workflow as well as used metrics and used data. This is necessary to understand the assessment study (chapter 8) and interpret the results correctly.

6.1 General background

The NetAScore toolbox (full name: Network Assessment Score Toolbox for sustainable mobility) was published by a team of researchers at the department of Geoinformatics (Z_GIS) at the University of Salzburg, Austria. One research area of the department focuses on research in mobility and geoinformatics, named Mobility Lab. The Mobility Lab is mainly responsible for the publication of the NetAScore toolbox as well as its advancement. The Mobility Lab sees itself at a higher level than transportation planning because their research has space as the overarching concept and spatial conditions and their influence on mobility in mind. The Mobility Lab generally conducts research for the subsequent application of geoinformation.

NetAScore is a command line software tool for assessing infrastructure suitability for cycling and walking. It is open source, available over GitHub, meaning the source code and the tool itself is open and free to use for everybody. It builds the foundation for numerous advanced analyses and therefore for the future of mobility research.

The origin of the NetAScore toolbox was a routing application for bicycles. The initiative of improving the routing application to create an open-source project for assessing infrastructure was taken for the usage of the tool within the company *TraffiCon* (Traffic Consultants GmbH). To consider electricity and mobility as relevant variables in energy spatial planning the company needed to estimate the suitability of road space for pedestrian and bicycle traffic to calculate the associated potential for sustainable mobility. To ensure that the spatial assessment models (walkability and bikeability index) can be used easily and sustainably, the project is open source.

In a study from 2015, Loidl and Zagel developed an indicator-based model for assessing road network quality for biking. The result was used in a routing application

(radlkarte.eu, not active anymore) (Loidl and Zagel, 2015).This was very similar to the NetAScore toolbox and can be seen as the predecessor of the tool.

The target audience is not only experts but also interested researchers from other domains, companies offering mobility planning support, the public sector as well as the general public. The index can be used in areas around the world and therefore you can easily compare results with each other. If the area of interest has specific conditions, the weights can be adjusted and you get a result that considers all factors relevant in that area.

The overall aim of the toolbox is to improve safety aspects for cyclists and pedestrians. By providing the toolbox, decisions in mobility planning should be supported. It aims to be versatile, open and transparent. What the toolbox doesn't aim to do is to provide a full GIS nor to reinvent network assessment tools or to provide full support or purpose specific developments.

In the future, the goal is to become more popular and to make it possible for other researchers or interested people to contribute to the development of the toolbox. There are plans to develop a QGIS Plug-In out of the existing toolbox. Contributions should help further develop the tool. NetAScore aims to be used as a tool for planning and for evaluating the transport environments in cities.

Some limitations are that it is only a model of the conditions on the street, meaning it does not completely depict reality. The toolbox aims to give an objective perspective of bikeability and walkability. It must be mentioned that local knowledge of street conditions in that context sometimes is more accurate than an overall model. To calculate bikeability the toolbox uses the average cyclist. It does not aim to depict all different kinds of users (profiles) but an average perspective.

6.2 Selection of NetAScore

As stated in chapter 1.2 this thesis can be seen as the first one testing the NetAScore toolbox. This is relevant for the further establishment, publication and development of the NetAScore toolbox. What makes the toolbox stand out against other tools and therefore led to selecting the NetAScore toolbox is stated below.

- Free availability via GitHub: published source code and guide

- Worldwide usage: when using OSM data, otherwise: GIP data for Austria
- Transparent and reproducible
- Easy usage: because of Docker
- Customized settings (mode profiles)
- Datasets can be combined/optional datasets can be used for more detailed results
- Bringing in the Geoinformatics Perspective: combining network attributes with additional datasets (buildings, waterbodies)
- No application to Vienna yet (in that detail)

6.3 Technical background

The toolbox provides a digital representation of road space in a GIS, meaning a model of the road space. The digital representation is built as a network with the axis of the street representing each street. By running the NetAScore toolbox, it adds a numeric indicator to each street segment that defines its suitability for cycling and walking.

As mentioned before, GitHub is the platform where the tool can be accessed. GitHub is an online platform where developers store, share and manage their code. As of June 2023, it is the largest host for source code. A repository is a storage place inside GitHub with an address to access a certain page. In the case of NetAScore, the toolbox is stored in a GitHub repository. The index can be used as a command line software tool. It is programmed with Python and based on a PostgreSQL database. Running the toolbox, a docker container can be used or different python libraries need to be installed to run it locally. These two options exist for the user to get the resulting dataset (see figure 23).

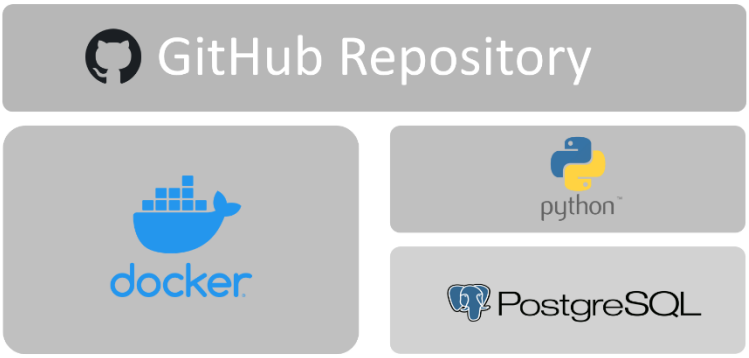

Figure 23: Technical Set Up NetAScore

Running NetAScore in Docker means no software or python libraries besides the Docker Desktop application need to be installed. Docker provides a ready-to-use setup including a PostgreSQL database with PostGIS extension that is necessary to run the toolbox. Docker is a platform that provides needed software in containers inside the docker application. Containers can run in different environments of different users. This is a great advantage for this toolbox. However, running NetAScore in Docker can be slower than running it directly on the machine in Python.

Generally, the index is calculated for each street segment. By multiplying all indicators by its weight, the results for bikeability and walkability are calculated (see Formular below). Each edge (street segment) gets a value from 0 (low walkability/bikeability – less suitable) to 1 (high – more suitable) (Werner et al., 2023).

The formular below shows the general calculation of the index with some example numbers for selected attributes.

Attributes:

Indicator	Value	Value Weighting	Indicator Weighting
Max_speed	30	0.4	0.1
Number_lanes	2	0.5	0.2
Width	8	0.3	0.1

Formular:

$$index = \frac{\sum_{i=1}^{n} indicator * weight}{\sum_{i=1}^{n} weight}$$

$$index = \frac{0.4 * 0.1 + 0.5 * 0.2 + 0.3 * 0.1}{0.1 + 0.2 + 0.1} = 0{,}425$$

6.4 System Overview

To get an overview of the functionality of the toolbox, figure 24 shows the files that the GitHub repository contains. To understand the workflow of the index, this overview is helpful.

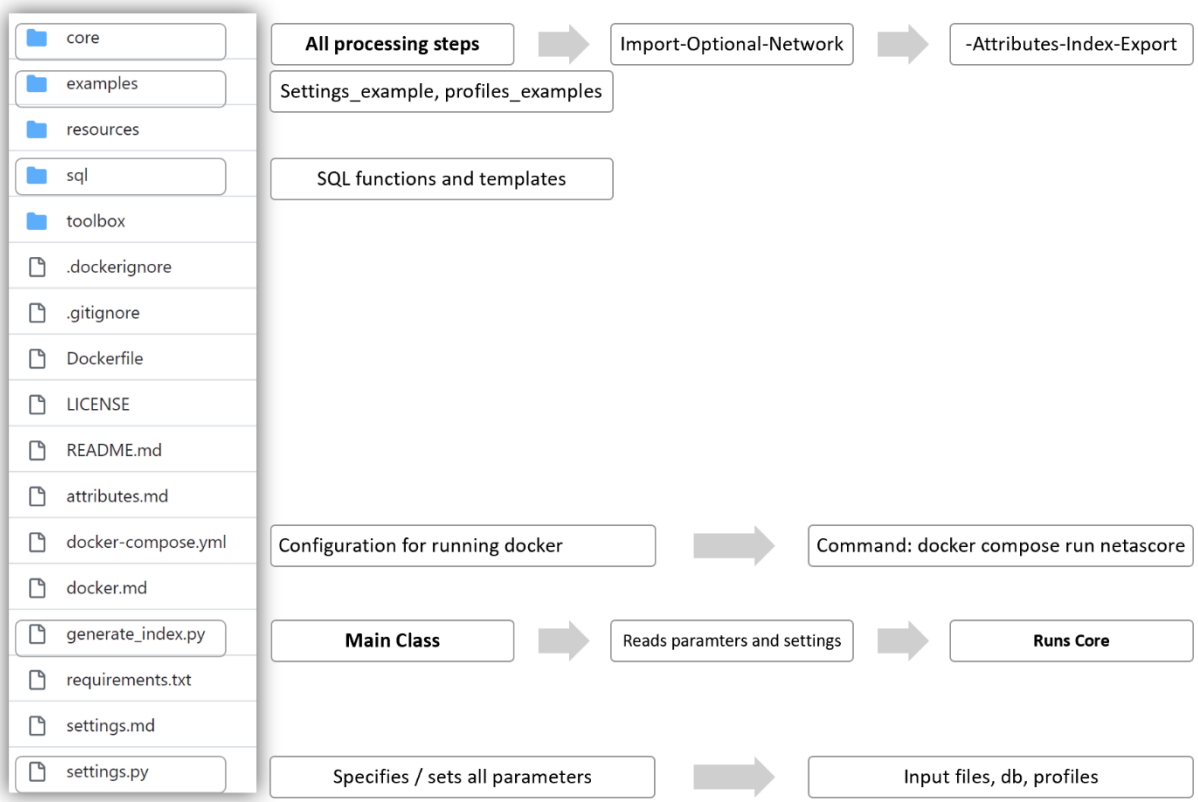

Figure 24: Overview GitHub Repository NetAScore, source: Werner et al., 2023

The *generate_index.py* file is the main class which is necessary to call all processing steps and settings made. The processing steps consist of 6 python scripts called after one another. The *import_step.py* imports all necessary datasets that were configured in the settings file before. The *optional_step.py* will be run if any optional datasets need to be imported. The *network_step.py* creates a network dataset by merging data-subsets (GIP IDF Tables) and reducing it to relevant edges and attributes. The outputs of this step (*network_edge* and *network_node*) are used to derive the attributes in the *attributes_step.py* (see chapter 6.5). After that, the *index_step.py* applies all weightings to the attributes that were defined in the Profiles for walk and bike (*profile_bike.yml* and *profile_walk.yml* in folder *examples*) using the index formular. Finally, the *export_step.py* creates the GeoPackage file as it is defined in the settings file and exports it to a local directory.

The workflow of running the toolbox can be explained as follows. Figure 25 shows a schematic representation of how the toolbox works.

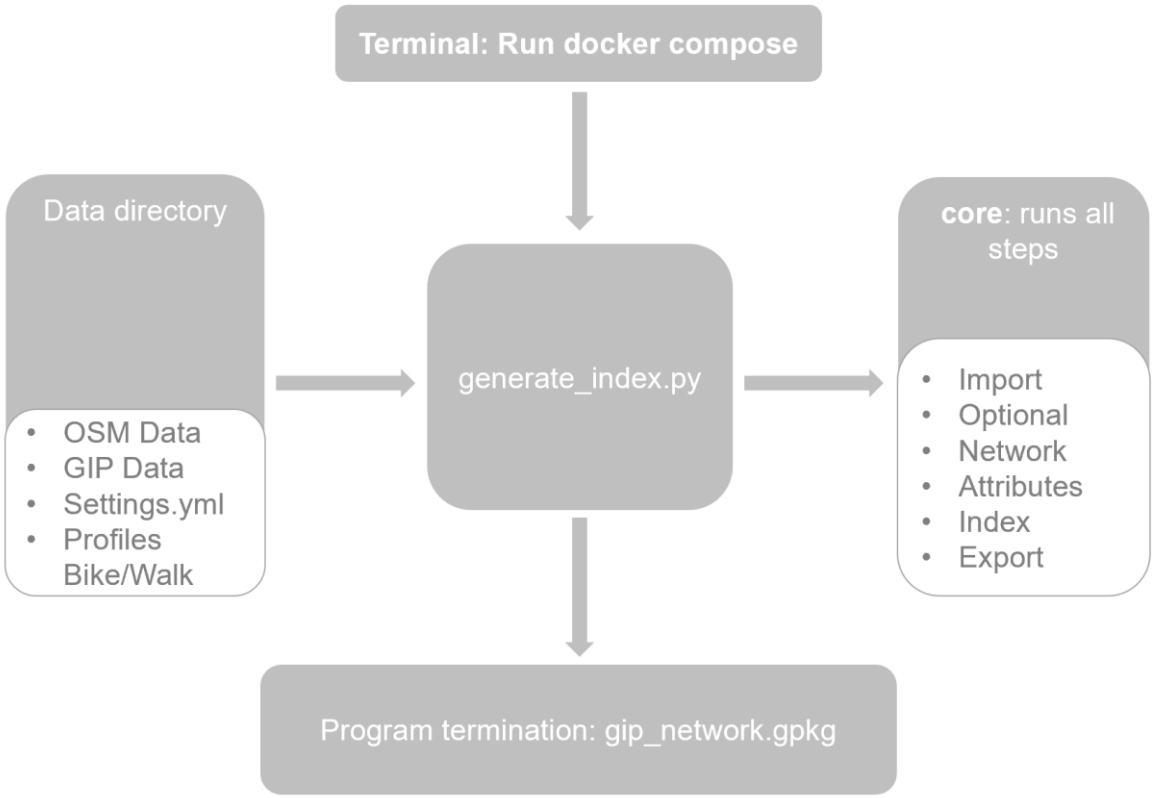

Figure 25: Workflow of NetAScore

First, the user must run the command *docker compose run netascore* in the terminal. This can only be done when Docker is installed already. Further it is necessary to create a new folder with all input data in the correct form, the adjusted settings file as well as the modified profile files for cycling and walking. After running docker compose it uses all settings that were defined in the settings file provided. The *generate_index.py* script is called and runs all steps recently described (Import to Export). The program then terminates with a GeoPackage being exported to the personal directory. This file can be imported to a GIS to visualize and analyze the index results.

6.5 Indicators and Attributes

Each input dataset (OSM or GIP) has different attributes that describe the street segment. These attributes are taken to calculate the overall result of bikeability/walkability. The attributes can be weighted within the settings of the toolbox to get customized results. Each indicator can be given a value from 0 to 1 depending

on its importance (see formular). In Table 4 the attributes that NetAScore uses for calculation are listed and explained. The column *weighting default* means the standard setting when using NetAScore without adaptation. The column *weighting custom* shows the weights that were used for the assessment study. They were comprised of the conducted interviews and out of previous literature. A more detailed explanation of how these values were created can be found in chapter 8.1. The main attributes that are considered as most important are highlighted in Table 4.

Table 4

NetAScore metrics

metric	source	method	Weighting default	Weighting custom
Bike infrastructure	GIP	Existence/ type	0.2	0.2
Buildings	OSM (opt.)	Proportion 30m Buffer (0-100)	NULL	0.1
Crossings	OSM (opt.)	Crossings 10m Buffer	NULL	0.1
Designated Route	GIP	Local/regional/national/intern/no	0.1	NULL
Facilities	OSM (opt.)	POIs in 30m Buffer	NULL	NULL
Gradient	DEM (opt.)	In 5 classes (0-12%)	0.1	NULL
Greenness	OSM (opt.)	Proportion 30m Buffer (0-100)	NULL	NULL
Max Speed	GIP	0-130	0.1	0.2
Noise	Lärminfo.at (opt.)		NULL	NULL
Number Lanes	GIP		NULL	0.1
Pavement	GIP	Type	0.1	0.1

metric	source	method	Weighting default	Weighting custom
Width	GIP	5 classes	NULL	0.1
Pedestrian Infra.	GIP	Existence/ type	NULL	NULL
Road category	GIP	Type (primary, sec.,…)	0.3	0.1
Water	OSM (opt.)	In meter	NULL	NULL
Parking (not used)	Not available	Boolean (y/n)	0.1	NULL

Note. Based on Werner et al., 2023.

In the *attributes_step.py* all attributes are derived from the network dataset to combine them to form the index. The attribute *bicycle_infrastructure* is derived from a combination of attributes in the original dataset. Values are classified as *bicycle_way, mixed_way, bicycle_lane, bus_lane* and *no*. For this, the GIP dataset *gip_link* and the features *basetype* and *bikefeaturetow* are used. Figure 26 shows a code snippet from that is called to calculate the attribute bicycle infrastructure based on GIP data. For example, the category bicycle way is assigned to a segment if the *bikefeature* has the value *RW* or *RWO* (RW = bicycle way with mandatory usage; RWO = bicycle way without mandatory usage).

```
IF basetype_array IS NOT NULL THEN -- TODO: condition correct?
    FOR i IN 1..array_length(basetype_array, 1) LOOP
        IF bikefeature_array[i] IN ('RW', 'RWO') THEN
            indicator_values := array_append(indicator_values, 1);
        ELSEIF (bikefeature_array[i] IN ('GRW_T', 'GRW_TO', 'GRW_M', 'GRW_MO') AND basetype_array[i] <> '7') THEN
                            -- (bikesigned_array[i] = '1' and basetype_array[i] <> '1') OR -- TODO: adaptation to client
                            -- (basetype_array[i] = '7' and designated_route <> 'no') -- TODO: adaptation to client
            indicator_values := array_append(indicator_values, 2);
        ELSEIF bikefeature_array[i] IN ('MZSTR', 'RF') THEN
            indicator_values := array_append(indicator_values, 3);
        ELSEIF bikefeature_array[i] IN ('BS') THEN
            indicator_values := array_append(indicator_values, 4);
        END IF;
    END LOOP;

    indicator_value :=
        CASE
            WHEN 1 = ANY (indicator_values) THEN 'bicycle_way'
            WHEN 2 = ANY (indicator_values) THEN 'mixed_way'
            WHEN 3 = ANY (indicator_values) THEN 'bicycle_lane'
            WHEN 4 = ANY (indicator_values) THEN 'bus_lane'
            ELSE 'no'
        END;
END IF;
```

Figure 26: Source Code NetAScore (File: attributes_step.py) , source: Werner et al., 2023

6.6 Input and Output Data

Network datasets are necessary as a database for the toolbox. These can be either a GIP OGD dataset or a OSM file. Networks are stored as a geographical dataset with Linestrings, meaning connections between coordinate pairs. They represent the middle line of a street. Linestrings are in the case of network datasets represented as graphs. Nodes represent the junctions/the location where graphs connect. Information can be attached to the graphs and nodes to allow further analysis and evaluation.

GIP (graph integration platform)

The Graph Integration Platform forms an Austria-wide uniform intermodal transport reference system forming the basis for the provision of high-quality traffic data and its exchange between different organizations. In mathematical terms, this transport reference system forms a graph model of the entire publicly usable transport network.

The GIP can be used for various purposes, e.g. for the management of streets and roads, as a reference basis for accident data management, as a data basis for traffic information and for model calculations and as a basis for cartography. The GIP as a graph also serves as a basis for hierarchical route calculations in the network for various application purposes of traffic planning, traffic organization and traffic

management. With the GIP, the Austrian administration has created an integration project that is unique in Europe.

There are different versions of the GIP that are publicly available (at data.gv.at).

- Routingexport (IDF Files)
- GIP Network Basenet
- GeoPackage Referenceobjects

The Routingexport is a large zip File with IDF tables. The file format IDF is a data exchange format and text based. The file is extracted by the toolbox and the different tables are later comprised to form the *network_edge* and *network_node* files.

OSM (Open Street Map)

Open Street Map is a free geographic database that is comprised out of user input. Meaning the platform exists only because of users' contribution. Urban areas tend to have high data quality whereas rural areas and less populated and less developed areas have lower data quality. OSM data is helpful in the case of the toolbox because it is available worldwide with the same attributes. It is possible to download all OSM entries of one country as PBF Files. This is done in the case of the toolbox.

Optional datasets can be used in addition for calculation of the index. These can be DEM (Digital elevation model) files that are necessary for the attribute *Gradient* (when using GIP data, this is already included). Noise files (Geopackages with polygones on noise) can be added. OSM data can be used as additional datasets when using GIP as network dataset for special attributes like *Greenness, Facilities, Water, Crossings* or *Buildings*.

After running the toolbox, the output dataset will be created automatically. A GeoPackage file with the layers *edge* and *node* is exported. The layer *edge* comprises all street segments with the attribute values and calculated index values. This file is used for visualizing bikeability/walkability for an area.

The file format GeoPackage (.gpkg) is an open, non-proprietary and independent data format for GIS built over a SQLite database.

As mentioned, the export dataset is a GeoPackage File with a layer called *edge* that contains information on walkability and bikeability. An extraction of the attribute table can be seen in figure 27. The value *index_bike_ft* and *index_bike_tf* define the calculated index for each street segment for both directions (from_to and to_from). The field … *_robustness* explains the quality of the data basis, meaning what metrics contribute most to the result of bikeability/walkability. It is calculated by dividing the sum of weights by the total weight (more details can be found in the source code, in the file: *calculate_index.sql.j2* on GitHub).

index_bike_ft	index_bike_tf	index_bike_ft_robustness	index_bike_tf_robustness	index_walk_ft	index_walk_tf	index_walk_ft_robustness	index_walk_tf_robustness
0,47	0,47	1	1	0,6444	0,6444	0,9	0,9
0,43	0,43	1	1	0,4167	0,4167	0,8	0,8
0,47	0,47	1	1	0,4208	0,4208	0,8	0,8

Figure 27: Screenshot NetAScore Export Table

6.7 Workflow

The general workflow of the usage of NetAScore in this thesis is explained in figure 28. A more detailed description follows in chapter 8.

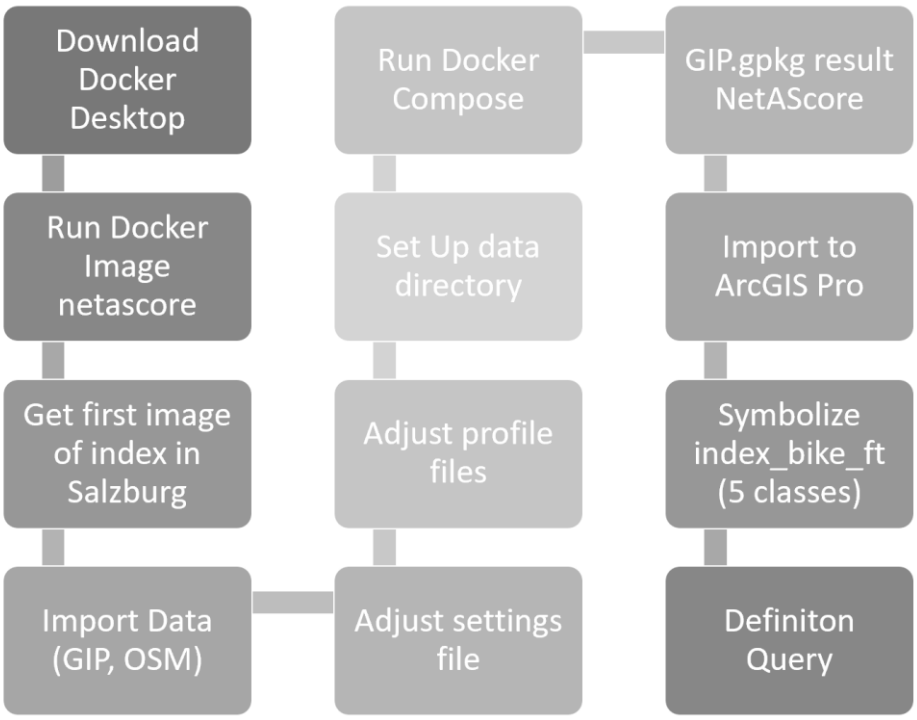

Figure 28: Workflow NetAScore calculation

Basically, this workflow can be used again for another use case or for different attributes or different input data. First, the desktop version of docker needs to be downloaded, if running NetAScore in docker. To get a quick overview, the ready made

docker image can be run. This is a predefined area (in this case Salzburg City). It shows a general application of the index on Salzburg. For this thesis, GIP data will be used to calculate Vienna's bikeability. Therefore, the needed ZIP file with IDF tables must be imported to a data directory. Additionally, if needed, optional attributes can be comprised out of OSM data, therefore the OSM PDF File for Austria must be imported as well. The settings file must be adapted (change database connection parameters, filename of input data and profiles). The profile file for bike (*profile_bike.yml*) needs to be adjusted according to the customized weights. After setting up a new directory the docker compose file can be run in the terminal. This process can take a long time (1 hour), depending on the input data. For a faster calculation the locally run python version is an option. The GeoPackage can then be imported to a GIS. To symbolize the index, it is helpful to categorize values into 5 groups and assign a color scale. For the use case of this thesis, the definition query was set to only show street segments where the bicycle has access (access_bicycle=1). The assessment study and the continued workflow can be found in chapter 8.1.

7 Use Case: Vienna, Austria

7.1 Background

In recent years cycling has gained a more popular status in Vienna. This hasn't always been the case. In the 1960s and 1970s planning was mainly focused on cars since it gained popularity because more people could afford their own car. For example, the bike network in Vienna even decreased in the timespan from 1970 to 1977 by 50%. Later, in the 1980s a trend shift happened and it increased to 170km by 1986. Numbers are higher because in that timespan the Danube Island was built, which has a length of 21km and therefore also long cycling routes. The focus of cycling remained to be for leisure. In the early 2000s cycling was first seen as a mode of transport for everyday life and commuting. A main step in the administrative process happened in 1997 when decentralization made it possible that each district is responsible for its cycle lanes.

Since the early 2000s cycling infrastructure and cycling rates have been increasing. Figure 29 shows the development of the modal split since 1993.

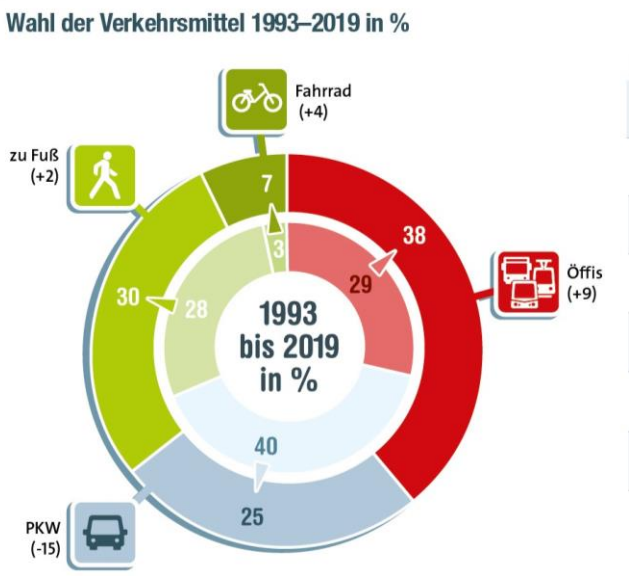

Figure 29: Chosen transport modes in Vienna 1993-2019 (%), source: Stadtpolitik Wien

The city is currently working on the upcoming planning concept for the next ten years since the old concept was targeted for 2025 (STEP25). In an interview with APA press agency, Thomas Madreiter, planning director of the city, says:

> "Among other things, we will massively push ahead with urban greening, but also with the expansion of gentle mobility such as cycle paths. Space and area

> are not infinite resources, so in the future it will be a matter of intelligent compaction. We will then no longer be able to afford the high seals, especially for motorized private transport. Sealing leads to heating up the city and less nighttime cooling." (derStandard, 16.04.2023)

The City of Vienna is conducting a survey where they ask 9000 people about their living situation. The latest survey asked questions concerning the future of individual mobility. 90% of the participants answered that it is not necessary to own a car in Vienna. Madreiter says that he expects that in the next 20 years privately owned cars will drastically be reduced. It needs to be distinguished between owning a car and using a car, he is referring to shared mobility as a solution for the space problem in cities. In Vienna the share of people using motorized mobility decreases, being the only city in Austria where it decreases (in the last 10 years around 5%). Madreiter says, living in a city means being exposed to conflict. The ability to have a dialog is essential for being part of the city. He sees the city as the solution not the problem, as he states in an interview at Wiener Zeitung by Martin Heintel (Heintel, 2020).

The attitudes of decision-makers are reflected in the existing transport infrastructure. Thus, it is not surprising that cities that generously promote motorized transport have a low proportion of cycling and those that promote cycling have a high proportion of cyclists (Meschik, 2008).

As one expert states, since 2020 there has certainly been more progress in the field of cycling in Vienna than ever before. But because it has been at such a low level so far, a fivefold increase is great progress. This must be seen realistically (Expert interview 3).

7.2 Statistics for Vienna

Some interesting statistics to understand the situation in Vienna are listed in this chapter.

As of 1st January 2023 1.982.442 people live in Vienna. The 2 million mark will even be reached by this year, 2023, prognosis says (Stadt Wien Bevölkerungsstand, 09.08.2023).

In Vienna, the street network has an overall length of approx. 2800 km. 1700 km of those streets are considered as part of the cycle network (2023). The cycle network considers all bike ways (meaning all roads that are declared bike ways). It must be considered that only 10% of all bike ways are bike paths, meaning only 170km of the 2800km street network (6%) have physically separated bike paths (Wiener Straßennetz, 10.07.2023).

The City of Vienna is currently working on a five-year cycle infrastructure expansion program, which was announced in the 2021 government agreement. An additional 20 million EUR per year is to be made available for this purpose instead of approximately EUR 6-7 million per year hitherto. The city government aims to increase the share of cycle paths in Vienna's total traffic area to 10% (currently 1%). In addition, the mobility concept states that by 2025, 80 percent of Vienna's journeys should be covered by public transport, cycling or walking.

In 2021, approximately 700 000 cars were registered in Vienna. A parking spot has a minimal area of 12.5 m^2. Calculated for all cars this means an area of 900 ha (9km^2). This is 3 times the size of the 1st district of Vienna (figure 30). Car traffic occupies 15% of the total area in Vienna as of 2019.

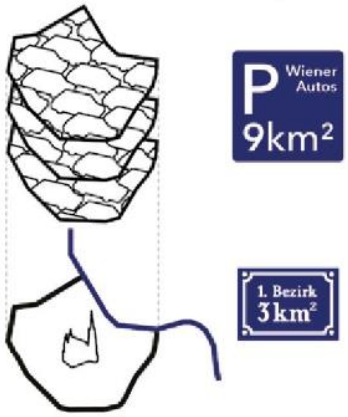

Figure 30: Space occupied by cars in relation to area, Vienna, source: Gerechte Stadt muss sein!

Further, parking costs are comparatively little in Austria's cities compared to the EU average as figure 31 by the European Environment Agency from 2016 shows. In Amsterdam parking in the city center for one hour costs most, followed by Stockholm and Copenhagen and Paris. Numbers of car modal share in comparison show that parking prices influence the usage of the car (European Environment Agency, 09.08.2023).

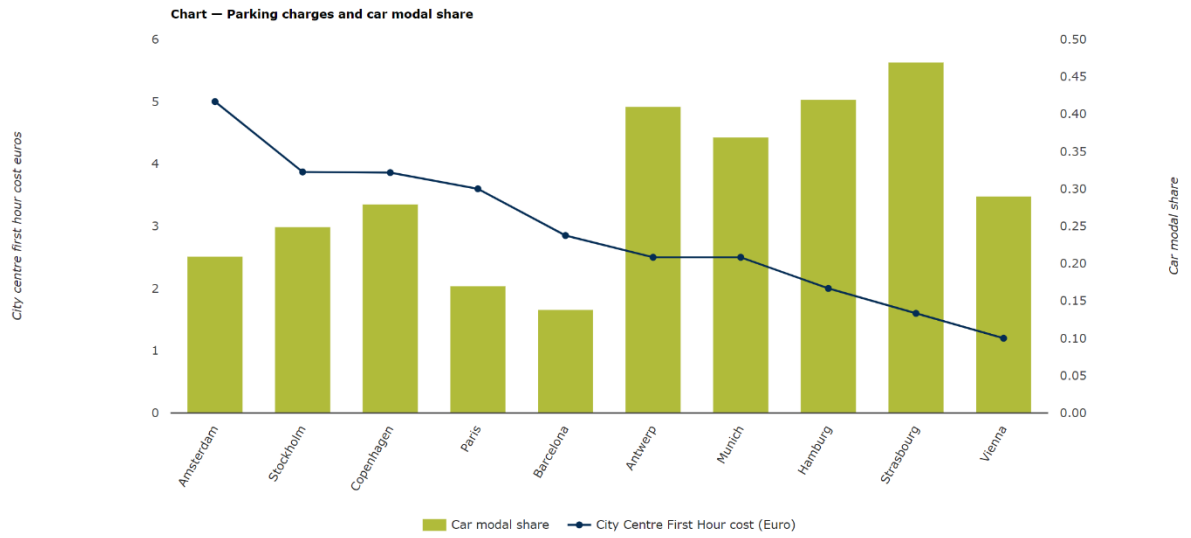

Figure 31: Parking charges for one hour, European comparison (2016), source: European Environment Agency

According to numbers from *Arbeiterkammer* from 2017 the investment in cycling infrastructure is 3,20€ per capita in Vienna per year. In Amsterdam it is 11€, in Copenhagen 35€ (Gerechte Stadt muss sein!, 08.08.2023).

As data from 2018 from the ministry of Transport can tell, the most common reason for mobility in Austria is work. 60 % of employees use the car, although more than half of employees live less than 10 kilometers from their place of work. 37% of Viennese people live less than 5% away from their workplace. Cycling in Austria thus has a high potential. Since many daily journeys are work journeys, the commitment and promotion of cycling within companies also plays an important role. The initiative *JobRad* aims to increase cycling trips to work by setting financial incentives if a company buys bikes for their employees. Further, the initiative *Österreich Radelt* aims to motivate employees to cycle by competing with their colleagues and winning prizes (VCÖ Presseaussendung, 09.08.2023).

The city has certain strategic and long-term goals to change the modal split towards more active mobility as well as the overall aim of CO^2 reduction. They can be found in

the STEP25 (City development plan for the period 2015-2025). These goals can be seen as a motivational factor for investing in cycling infrastructure. Still, these are not legally binding goals, meaning they are often not fully reached in the initial period.

According to an expert, the targets set in STEP2025 are unlikely to be met, according to current figures. Still, the targets lead in the right direction. If these goals should really be achieved, the city might have to do more but this remains a political issue. Further, the STEP can be interpreted differently. Politicians have the means to control the budget (Expert interview 2). The next city development plan is currently created by MA18 (explained in chapter 7.3.1). The new target will be 2035 (STEP35). Content is not published yet.

Vienna is a compact city meaning that public space is rare and tight sometimes. Especially if green areas, public transport, cycle and walking paths should all have adequate space. In cities like Berlin or Munich they have a different structure and wider streets. Combining all different needs in a compact city is a challenging process (Expert interview 1).

To understand the situation of cyclists in Vienna, the Radlobby conducted the *Fahrradklimatest.* 3000 participants were asked how safe they feel during cycling and how they perceive the characteristics of cycle paths.

Cyclists in Vienna rate the situation of public rental bicycles as well as the accessibility of the city center as positive. According to survey results, in Vienna cycle lanes are too narrow. The feeling of safety on cycle paths and lanes is assessed negatively as well as the traffic lights for cyclists. The reasons why participants ride their bike were the following (ranked according to their priority): Environmental friendliness, health, flexibility, fun and time (Radlobby Fahrradklima Test, 09.08.2023).

There are push and pull factors to increase cycling rates. By increasing the price for parking, closing certain roads for cars and setting speed limits that’s measures to push citizens into the right direction. More measures like supplying good quality infrastructure for cyclists or providing enough parking sports for cyclists aim to pull citizens into the direction of using active mobility forms.

7.3 Planning for cycling

This chapter aims to explain how the planning process is organized in the city of Vienna concerning bicycle infrastructure. As mentioned, the planning process is decentralized meaning districts have a certain competence on their own. This means districts should and must be involved. Further, there exists a central budget for planning and building cycle paths since 2003 which makes it faster and easier to implement infrastructure.

7.3.1 Administration

In the municipal administration of the city of Vienna there are different departments that are responsible for certain tasks. These are called Magistrate (MA) and are numbered. The MAs that are relevant for cycle planning are described as follows. The MA18 is responsible for the strategic position of the city, for example publishes the city development plan (STEP25). MA18 creates the ideological meta-structure, and they are hierarchically one step higher in the planning stage than the implementation departments. Traffic organization and technical traffic matters are executed by MA46. And MA28 is responsible for road management and road construction. Further, there are the districts and their political level as well as the city policy. In addition, the mobility agency is responsible for organizing communication and coordination between different players. The nongovernment organization *Radlobby* aims to represent citizens' will and interests concerning cycling. All these players meet on a regular basis to discuss problem zones within the cycle network as well as compile the new bicycle path expansion program for the next years (Expert interview 1).

7.3.2 Budget

A budget of 25 million euros for improving Vienna's cycling infrastructure has been announced for implementation in 2023, after 10 million euros were invested in 2021 and 26 million euros in 2022. This year, a total length of 20 kilometers is planned to be built, of which 70% are new cycle paths, partly mixed use with pedestrians. About 15% are bicycle streets (Fahrradstraße) according to the new traffic regulations RVS (for example Pfeilgasse and Argentinierstraße). Two thirds of the projects are closing gaps within the existing network to continuity.

Experts say that although the budget is four times as high as in previous years, it is hard to keep up with the work, because human resources are scarce too. If the budget

was raised again, it would no longer be possible with the existing team. Not only planners but also construction workers are in demand (Expert interview 2).

To put the numbers into context, ten times as much as for cycling is invested in public transport. Although in terms of modal split, PT numbers are only 3 to 5 times as high as cycling rates. In fact, there is enough money, it is just not used for cycling (Expert interview 3).

There was a nationwide study on how much money is needed to double cycling numbers in Austria. The result is about 800 million euros for Vienna. If 20 million euros are invested now, it will take three decades to reach the goal. Accordingly, it will take a long time to reach the aspired goals (Expert interview 3).

7.3.3 Process

Generally, planning cycling infrastructure is done in advance, as a supply for potential cyclists. This is the planning strategy in Vienna, furthermore also part of the official planning guidelines RVS. The RVS guidelines are not legally binding but still set the technical standard for road construction. A detailed book explains guidelines for building cycling infrastructure according to the current scientific and technical standards. The RVS was revised in 2022 and now contains new regulations concerning bike paths.

The law that regulates all issues on public streets builds the base for the RVS and for all planning is called StVO (Straßenverkehrsordnung). Regulations for cyclists in the StVO are, for example guidelines on how bicycles must be equipped.

Meschik, 2008 published a planning guide for cycling in Austria in 2008. The basic principles still apply today. The general workflow of a planning process is described below.

Prior to the detailed planning of cycling facilities, the needs should be identified and the approximate location of each link and its importance in the network hierarchy should be defined. If it is clear how important a segment is and where it is located it can be planned for construction. The following main steps are to be distinguished:

1. Determining the actual situation: define the planning area, survey the traffic situation, the accident situation, etc.

2. Develop a traffic situation to be expected in the future: how and where cyclists should ride.

3. Planning of the cycling network in a hierarchical order: main routes, sub-network.

4. Selecting suitable type of infrastructure: separate facilities or mixed traffic with other modes of transport; Guidelines when to use what infrastructure type are listed in the RVS and should be considered.

5. Tracing and detailed planning of intersections and surrounding areas.

Main cycling network Vienna

In Vienna, the main cycle network is the base grid for planners and is used to make decisions for new infrastructure or improvements. Everything that is not part of the main cycle network is in competence of the district. Routes that are not part of the main cycling network don't necessarily need a bike path. Other methods like traffic filters or mixed use of streets can be applied. Figure 32 shows a clipped image from the current main cycling network.

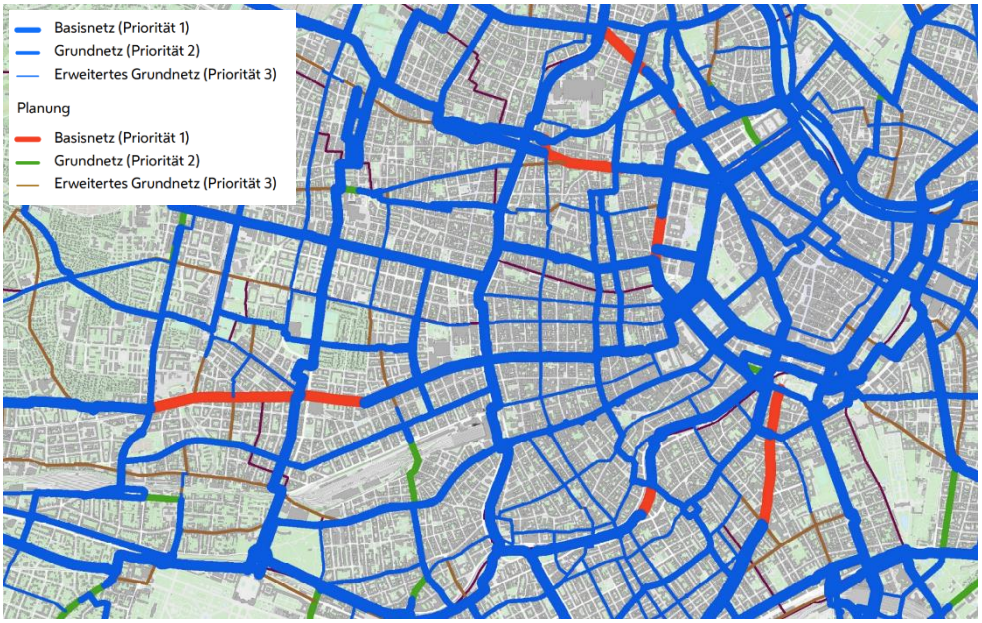

Figure 32: Extraction of main cycling network, source: Hauptradverkehrsnetz

The main network consists of:

- the base network 1 (**Basisnetz**): streets with main importance (cycle highways etc), thick blue in figure 32
- the base network 2 (**Grundnetz**): connections between districts, thin blue in figure 32
- the extended basis network (**Erweitertes Grundnetz**): connections within a district

Main planned cycling network Vienna

Added to the dataset of the main cycling network is the planned cycling network. This dataset comprises all street segments that are currently in the planning phase, meaning either under construction or planned to be constructed soon. Both datasets are publicly available at data.gv.at. Chapter 7.4 shows an overview of some projects that are planned for 2023. This dataset as well as the main cycling network are used in chapter 8 for the assessment study.

Influential Factors for planning bike paths

As stated on the website of the city, depending on the location, different cycling facilities are necessary. Essential factors for deciding on a particular type of investment are vehicle traffic volumes, the maximum permitted speed, traffic composition and the maintenance of road safety (Anlagearten Wien, 16.06.2023).

The following factors are considered in the planning process of cycling infrastructure in Vienna according to Experts (Expert interview 1, 2).

- Closing gaps: If there are gaps in the base network 1. Closing gaps is necessary to have a consistent and high quality of important routes.
- Improvement: Existing infrastructure that is important to the main network but does not fulfill technical standards will be improved. Identifying and improving dangerous parts is crucial.
- Quality: Generally, consistency and high quality remain of high importance for decisions. Also, the intuitiveness of a route plays a role. The goal is that cycling should be as easy as driving a car.

- Users: Areas where great user potential is expected, cycling infrastructure has high priority.

- Constructions: If some kind of construction work is being done, the opportunity is seized and cycling infrastructure is improved in that area. Taking advantage of this window of opportunity is practical.

- Separation: The current technical and scientific standard are physically separated bike lanes from traffic at a certain traffic speed. These standards change constantly. In the early 2000s it was common and seen as a good solution to build multi-use lanes. Now it is known that they are dangerous. Still, many of those multi-use lanes remain. Bike Streets are another concept that has gotten more attention lately and is applied to certain streets in Vienna.

Data collection

Data on cyclists' behavior is necessary for decision-making and therefore data collection is crucial. Data is collected in different ways. There are automated counting stations across the city that count all cyclists passing by. Data can be used to estimate the user potential and how cycling numbers develop. In addition, there are surveys for manual evaluation and manual counting. As a result, planners then know roughly how the development of bike traffic is on different axes and regions.

Radlobby created the *Radkummerkasten*, which is an online application, where citizens can mark certain spots or a problem zone (Radkummerkasten, 10.08.2023). Citizens are mostly experts of their own neighborhood or street and mostly know best what urban structures should be because of their local knowledge. The marked problems are being sent directly to the person in charge, either the districts responsible or to the MA. Since 2022, the Radlobby meets with the mobility agency four times a year to discuss problem zones. Further, each district gets an export list four times a year from the newly reported problem areas. All reports that have a particularly large number of comments or likes is examined in detail. At the meeting with the mobility agency, the 5 to 10 top projects are looked at closely and solutions are compiled. Figure 33 shows a map of Schottentor, 1010 Vienna where people marked areas that are missing bike racks, bike lanes or other issues.

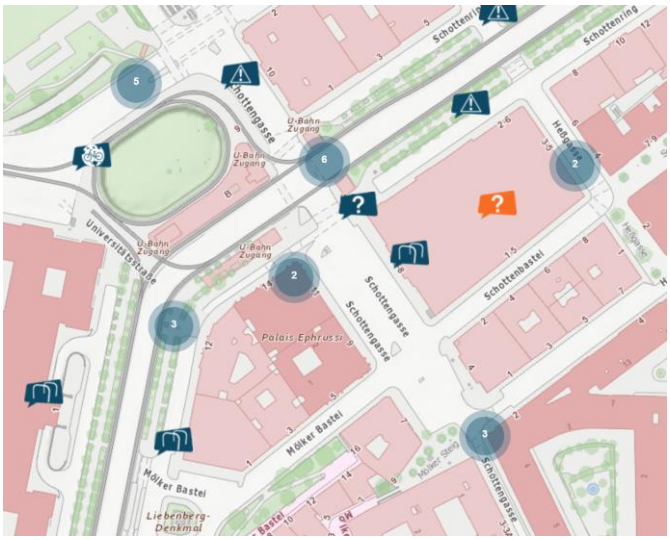

Figure 33: Extract Radkummerkasten Schottentor, source: Radkummerkasten

Another method of data collection is the Sag's Wien app that provides the possibility for citizens to mark problem zones, broken lights or anything relating to public infrastructure. The problems are then directly forwarded to the responsible department and processed. Then the city must decide where the priorities lie.

One interviewed person suggested that a group of experts is necessary to document the situation regarding the quality of the cycling network. Small things like missing traffic signs, floor markings or parking for bikes could be improved. To get an up-to-date picture of the situation on the streets this could be helpful (Expert interview 2).

Data like a travel survey or travel to work data is, to the knowledge of the author, not available for Vienna. Many studies used travel survey data to validate their model of bikeability (Hardinghaus et al., 2021). A mode choice model can simulate and aggregate cyclists' trips and therefore understand what areas and what roads people use. With this information a better image of areas with high potential can be drawn and therefore investments can be targeted more accurately.

There was a nationwide survey (conducted 2013-2014) on the volume of bicycle traffic in Austria called *Österreich unterwegs* by *bmvit*. More than 38,000 people were asked about their mobility behavior on two reference days. The survey was not continued nor does a similar survey exist (Österreich unterwegs BMK, 10.08.2023).

7.3.4 Critique

The interviewed experts mentioned different points of criticism on general problems regarding the planning process in Vienna.

The Radlobby stated that the main cycling network is not continuous enough and has too many gaps. They mentioned that a study by *grow bike* analyzed the cycling network and you can see clearly that existing routes don't overlap with suggested routes by the tool (Grow Bike, 10.08.2023). When analyzing the dataset, it can be concluded that the network is not continuous. Radlobby created its one cycling network and checked if the newly planned projects of the city are part of their network. In fact, routes that are part of the Radlobby cycling network are not yet part of the main cycling network. According to an expert, there is a study on the quality assessment of the main cycling network of Vienna that analyzed the network. The study is not publicly available. It's highly critical that these findings are not communicated, due to political reasons (Expert interview 3).

Radlobby further claims that there are 30,000 parking spaces for bicycles missing by 2025. In addition, opening one-ways for cyclists is an important step in improving routes for cyclists. So far, only 48% of all one-ways are open to cyclists. Radlobby aims to achieve 90%.

The *Dooring Problem* is well known and documented in Austria. Due to the widespread multi-use lanes, the problem remains. The dooring zone, as mentioned before, defines the area where cyclists are in great danger because of opening car doors on the right side of the street. Another problem that occurs with multi-use lanes is that cars need to overtake cyclists. Keeping a minimum distance of 1,5 m to cyclists is mandatory yet not performed enough. According to an expert, the Radlobby will still have to actively promote keeping distance from cyclists in the next decades.

Providing signs of cycle routes and destinations is necessary for orientation. Still, there is no concept for the signs in the city. The city has been working on new signage for many years but has not executed it yet. In addition, the cycle paths are not signalized in a self-explanatory way. The city of Vienna can take Denmark or the Netherlands as an example of designing cycle paths. It needs to be possible to distinguish cycle path from pedestrian paths on the first sight.

Radlobby further claims that an up-to-date cycling map with a detailed presentation of all cycle paths should be provided. The current official map is not good enough for orientation.

So far, political reasons are often deterring planners from expanding cycling infrastructure. In some districts, projects are rejected because of the fear of losing parking spots for cars.

7.4 Future of Cycling in Vienna

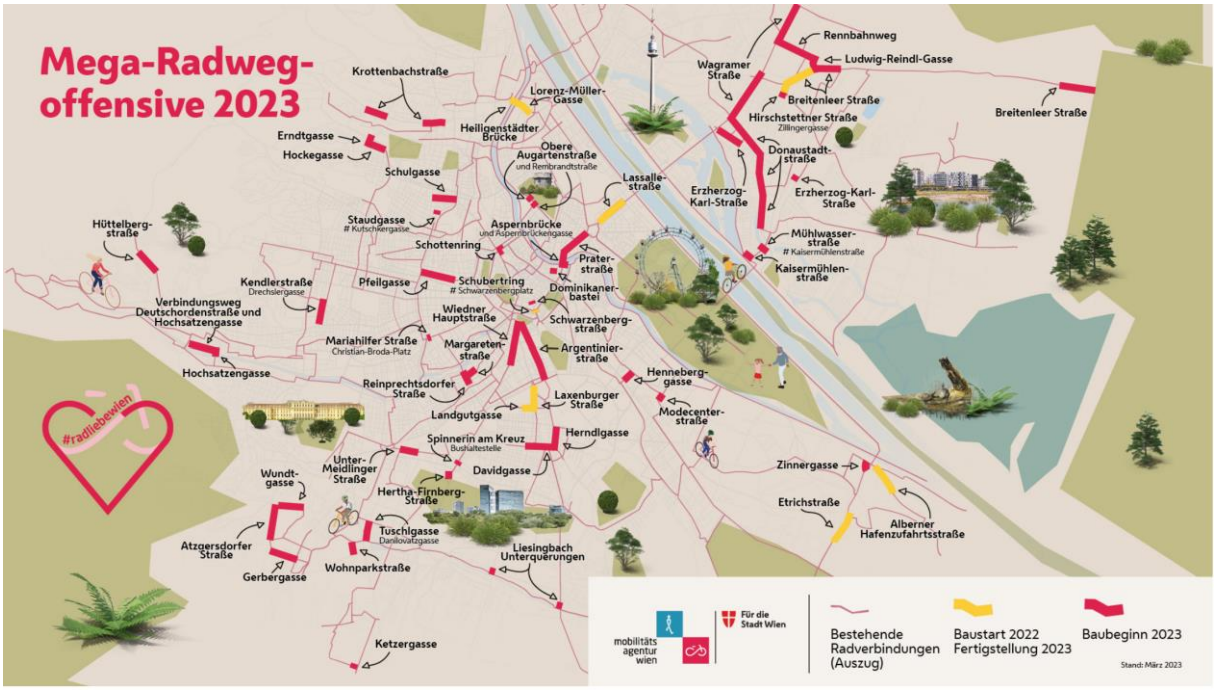

Figure 34: Mega Bike Path Offensive, source: Radwegoffensive

Figure 34 shows an overview of all projects that are under construction or completed in 2023. It's called the *mega bike path offensive* by the city of Vienna.

A total of 50 projects in the main cycle network are to be implemented this year. Most of them are in the 22nd district, followed by the 23rd, the 14th and the 2nd. After the introduction of parking space management, the opportunity to use the free space for sustainable mobility is given. Although about 20 projects are only up to 150 meters long and only a third of the projects are longer than 500 meters, by combining several projects it is possible to realize longer continuous routes.

There are huge differences for each district and therefore different mobility behavior. Public Transport is denser in the central districts. Districts like the 22nd or the 10th are

active and motivated to improve their cycling infrastructure. Still, they have a great area and don’t face the challenges that inner city districts do. The 19th district has enough space, but political will is still lacking therefore projects take longer and fewer cycle paths exist.

Since the last two years brought four times the budget and around 50 projects a year, there is already a great dynamic in this sector at the moment. It remains to be seen to what extent this will continue to be reflected in modal split figures. The expert is assuming that more people will cycle in absolute numbers, because the population is increasing. That doesn't mean that there is more in modal split. The proportion may remain the same (Expert interview 2).

In the new bike path offensive, the concept of bike streets is enlarged. Radlobby states that superblocks would be a good solution in Vienna and should be considered in the future as well.

8 Assessment study

This chapter describes in detail what was explained as a concept in chapter 3.3 already. The assessment study comprises the adaptation and calculation of the NetAScore bikeability index for Vienna as well as its visualization and spatial analysis.

8.1 NetAScore customization

The following indicators shown in table 5 were asked to be rated by experts. The original survey can be found in the appendix. This is a selection of all indicators used by the index, which can be found in chapter 6.3. The customization of the index was done before calculation of the final index result (see workflow in chapter 6.7, step *Adjust profiles*). The weighting *NULL* means that this metric is not considered when calculating the index result.

The presence of bike paths, bike lanes, bike-friendly traffic lights, safe bike parking places, etc. lead to more cyclists and define a good quality bike network and therefore should be considered when calculating bikeability. Therefore, the metric *bike infrastructure* is weighted high.

Because the level of stress, perceived and actual danger correlate with the speed of cars, the metric *max speed* was weighted high.

Table 5

NetAScore metrics Experts Rating

metric	Interview 1	Interview 2	Interview 3	Results	weighting
Bike infrastructure	90/100	90/100	90/100	270 → Priority 1	0.2
Buildings	70/100	20/100	60/100	150 → Priority 3	0.1
Crossings	60/100	80/100	20/100	160 → Priority 4	0.1
Designated Route	50/100	10/100	30/100	90 → Priority 5	NULL
Gradient	10/100	10/100	20/100	40 → Priority 8	NULL

metric	Interview 1	Interview 2	Interview 3	Results	weighting
Greenness	20/100	20/100	30/100	70 → Priority 7	NULL
Max Speed	90/100	80/100	60/100	230 → Priority 2	0.2
Noise	10/100	10/100	30/100	50 → Priority 5	NULL
Number Lanes (= Width)	90/100	80/100	60/100	230 → Priority 2	0.1
Pavement	20/100	50/100	80/100	150 → Priority 3	0.1

Note. Based on Werner et al., 2023.

8.2 Technical Set Up

For running the NetAScore Toolbox and for geographical analysis the following technical components were used.

- Used Software: Docker Desktop 4.16.3; Arc GIS Pro 3.0.3, PyCharm Community 2023.1.2, Microsoft Excel
- Used Computer: Microsoft Surface Pro 8, Windows 11
- Data
    - NetAScore Index, Version 1.0.0 (Werner et al., 2023)
    - GIP Routingexport ZIP (IDF Tables) (data.gv.at, Version: 11.07.2023)
    - OSM Austria PBF (download.geofabrik.de, Version: 11.07.2023)
    - Main Cycling network (data.gv.at, Version: 14.07.2023)
    - Main Cycling network Planned (data.gv.at, Version: 14.07.2023)
    - Administrative Data: District Borders (data.gv.at, Version: 14.07.2023)
    - Basemap: Basemap.at WMS (data.gv.at, Version: 01.07.2023)

8.3 Workflow Spatial Analysis

After customization of the metrics, the profile file (profile_bike.yml) was adapted accordingly. Then the index was run and resulted in the export of a GeoPackage with the new network dataset comprised out of GIP dataset and additional OSM data.

```
8:58:11 - Thank you for using NetAScore!
========================================
8:58:11 - Program terminating after 1:18:29 (hr:min:sec) at 17:26:17.
========================================
```

Program termination after 1 hour and 18 minutes. This was the final run of the toolbox. The results are described in this chapter.

The general workflow of this process is depicted in figure 7 in chapter 3.3. This is explained in greater detail below. Figure 28 in chapter 6.7 explains the steps that were necessary to run the index with the preferred settings and datasets. After the last step *Definition Query* (the definition query for the NetAScore dataset inside the GIS) the workflow will be continued in this chapter (see figure 35).

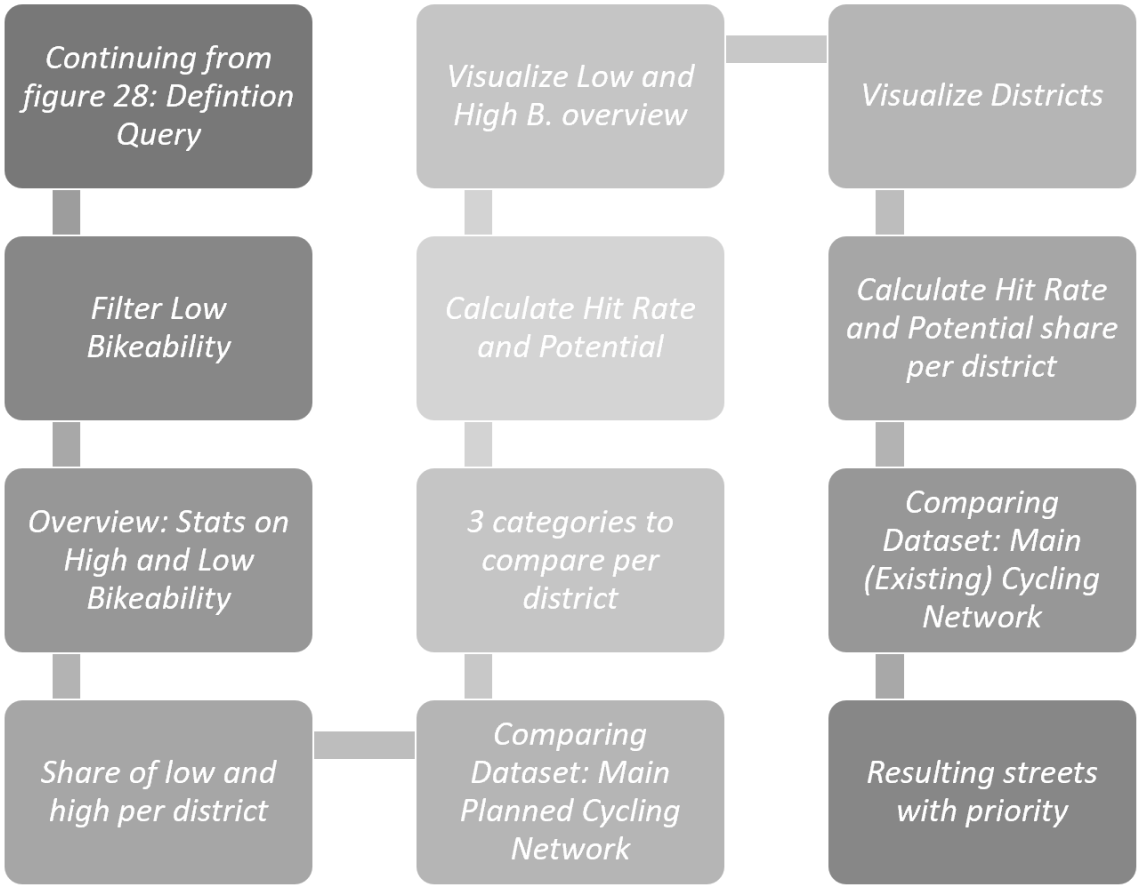

Figure 35: Continued Workflow from Figure 28

After importing the GeoPackage into *ArcGIS Pro*, the dataset for whole Austria appears. Clipping it with the borders for Vienna is the first step. As described in chapter 6.7 the column *index_bike_ft* was used to symbolize the index using 5 classes and a color scheme. When visualizing the first result, all streets were used for calculation. The problem zones needed to be extracted first: Streets where cycling is not allowed were extracted with the following query.

```
access_bicycle_ft = 1 AND access_bicycle_tf = 1
```

To get an overview of the visualized values, all segments with low and high bikeability were summed up, calculated with Excel (Result below).

Overall Evaluation Low Bikeability	221 km
Overall Evaluation High Bikeability	325 km

To understand the differences per district, the share of low and high bikeability was calculated and visualized with plots.

The index results were restricted to values below or equal to 0.49 to show low bikeability (using the following query). Those values were chosen because of the automatic classification with ArcGIS Pro.

```
access_bicycle_ft = 1 AND access_bicycle_tf = 1 AND index_bike_ft <= 0.49
```

Figure 36 shows the share of low bikeability per district normalized by all segments measured in that district. According to the NetAScore index, the 8th, 7th and 17th district have the most segments classified as low bikeability. These results take into account all streets where cycling is allowed without considering whether the street is part of the main cycling network or not.

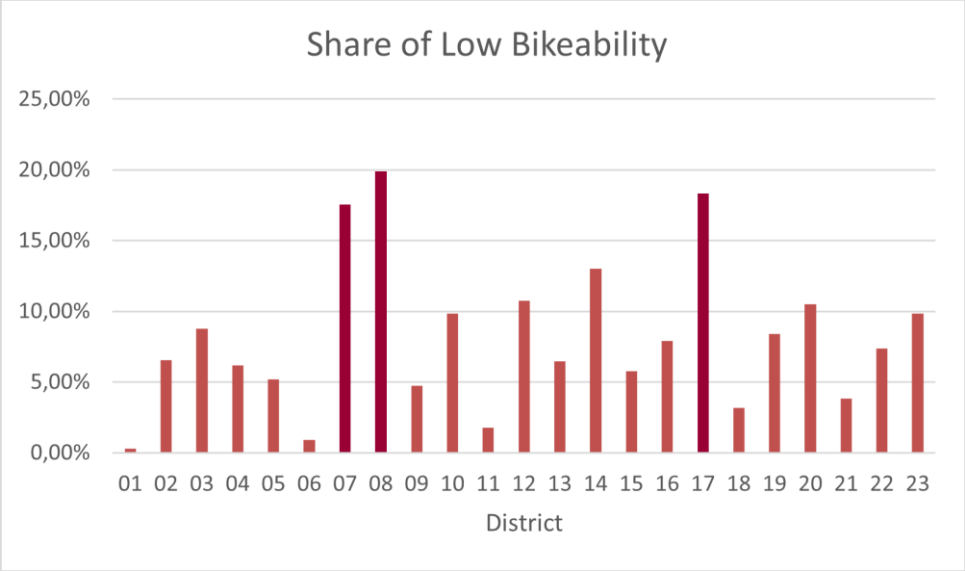

Figure 36: Share of Low Bikeability per District, Vienna

Then the index results were restricted to values above or equal to 0.57 to show segments with high bikeability (using the following query).

```
access_bicycle_ft = 1 AND access_bicycle_tf = 1 AND index_bike_ft >= 0.57
```

Figure 37 shows the share of high bikeability per district normalized by all segments measured in that district. According to the NetAScore index, the 1st, 20th and 4th district have the most segments with high bikeability. Results in the 1st district can partly be explained because one major bike path (Ringradweg) circuits the whole district.

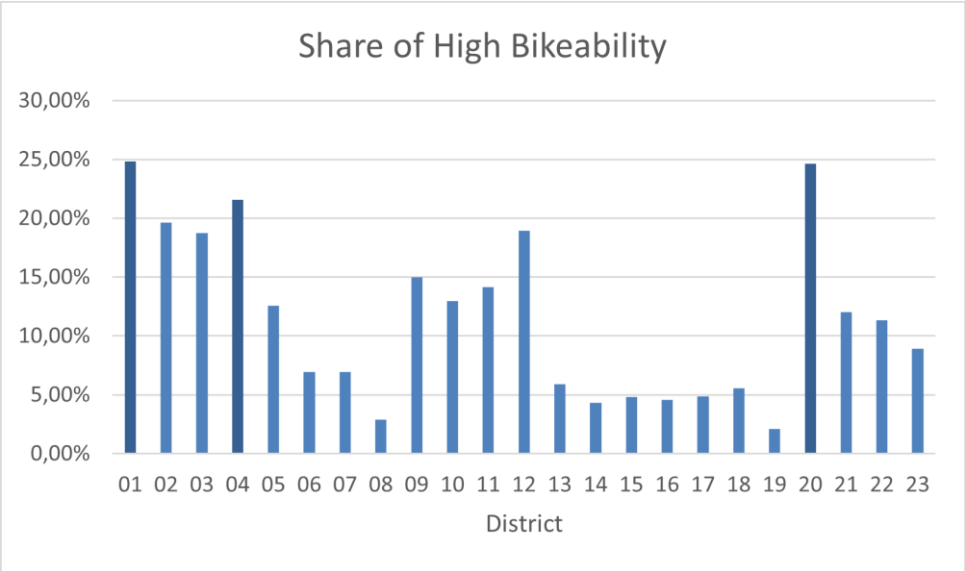

Figure 37: Share of High Bikeability per District, Vienna

After calculating the first statistics a comparing dataset was selected to compare low bikeability with the main planned cycle network by the city of Vienna (see: 8.2).

The dataset includes all currently planned infrastructure projects and is freely available at data.gv.at. Figure 38 shows an overview of all planned infrastructure projects per district in meters. The 21st, 22nd and 23rd district are leading. This correlates with the experts' statements.

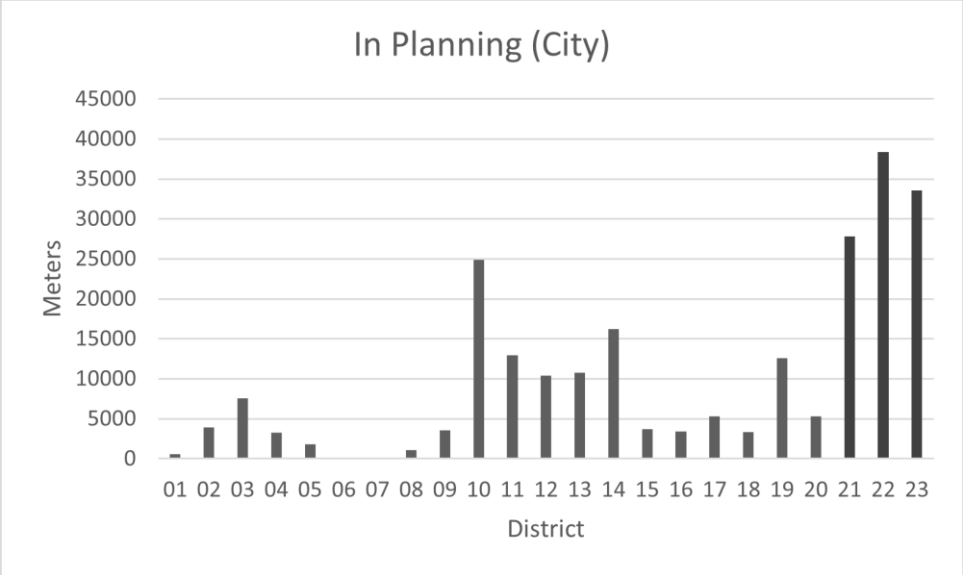

Figure 38: Main Planned Cycle Network per District

The following map (figure 39) shows all street segments classified as low bikeability as well as the main planned cycle network. For all maps visualized in this chapter the high

resolution .pdf can be seen and downloaded here: Drive (Full link in chapter 10.2) Figure 40 shows a close up of the dataset pictured in figure 39.

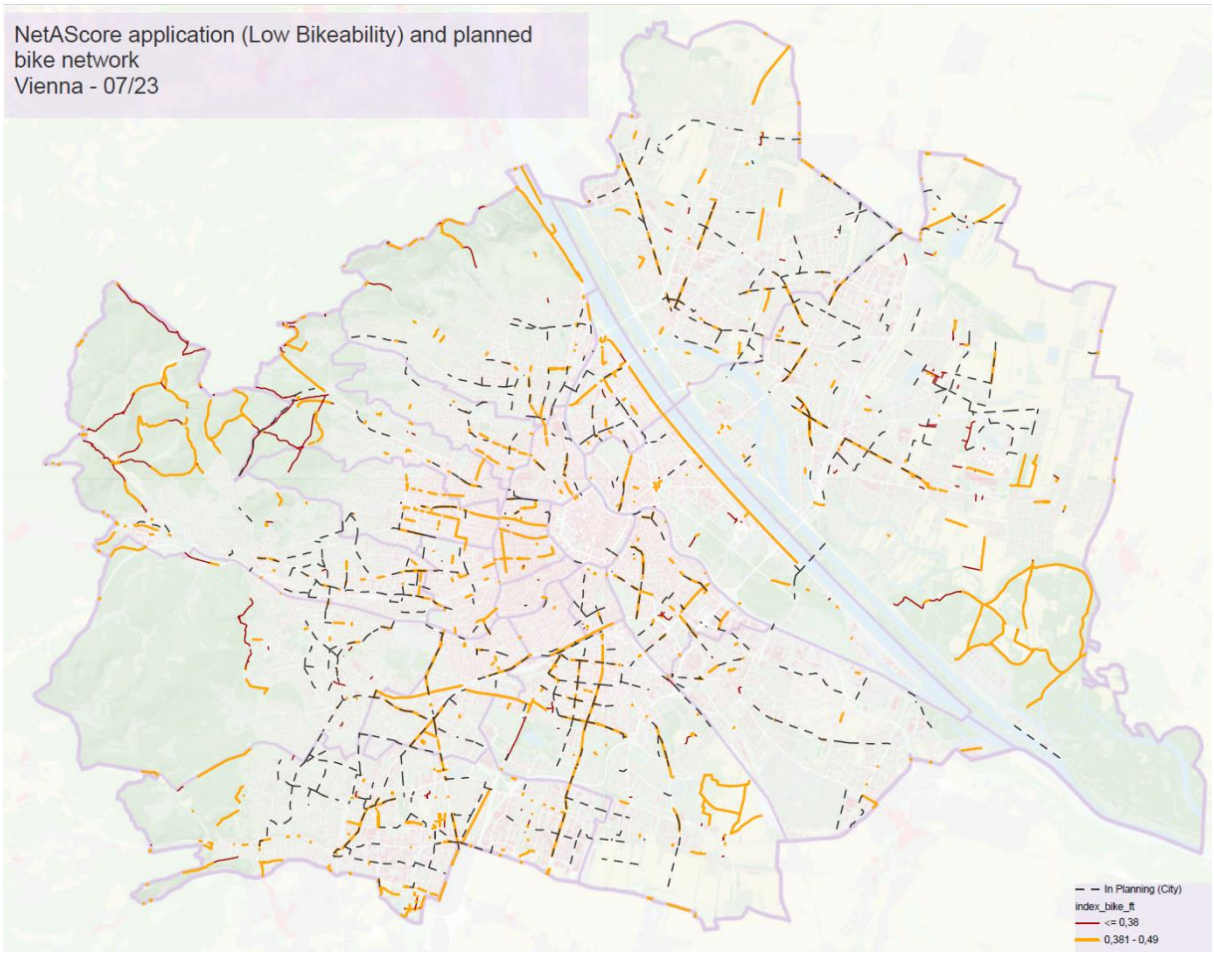

Figure 39: NetAScore Application Low Bikeability and Planned Network, Vienna

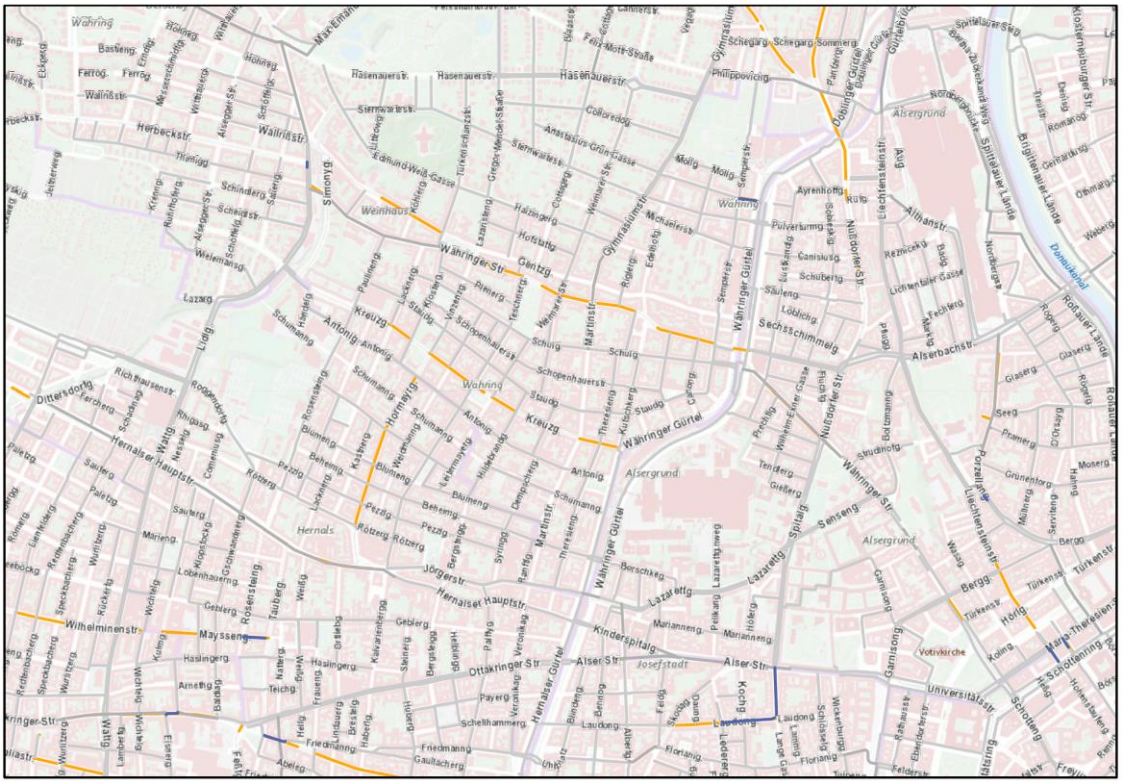

Figure 40: Zoom of Figure 39, NetAScore Application, Area 9th district, Vienna

This map (figure 39) already shows some limitations of the NetAScore calculation. Some segments were incorrectly classified, for example paths through woods, small pedestrian ways, main roads where cycling is not allowed or small roads that only connect private houses. Further, this visualization does not take into account whether a street is part of the existing main cycle network or not.

To analyze the result (figure 39) the following questions were asked and answered for each district.

1. What streets are low in bikeability (<= 0.49) and part of the main planned cycling network? This aims to answer what streets are detected correctly, because they are also considered in the planning dataset.

2. What streets are low in bikeability and not part of the main planned cycling network? This aims to answer what streets can be considered in the future for planning new or better infrastructure.

3. What streets are not low in bikeability but part of the main planned cycling network? This aims to show what streets where not detected by the index but are considered to be improved by the city.

For this, the following table was created and a list of all districts was conducted. Each street that was classified as one of the 3 categories was written down. The full list can be found in the appendix.

Head of Table from full Table Appendix 2 (see chapter 11.6).

District	Low B. + in Planning (1)	Low B. + not in Planning (2)	In Planning + not Low B. (3)	Est. Hit Rate %	Potential m

The term *Hit Rate* can be understood as a measure of sensitivity. To calculate the *estimated Hit Rate*, segments that were classified as low bikeability and are part of the main planned network were measured. The length of all streets from section (3) and (1) were measured to calculate what percentage of streets were *detected* meaning covered in the planning dataset and classified as low bikeability. This is called *Hit Rate* because the index found the right streets that are already considered. This means that the index can find potential segments that are not yet in the planning process but should be considered.

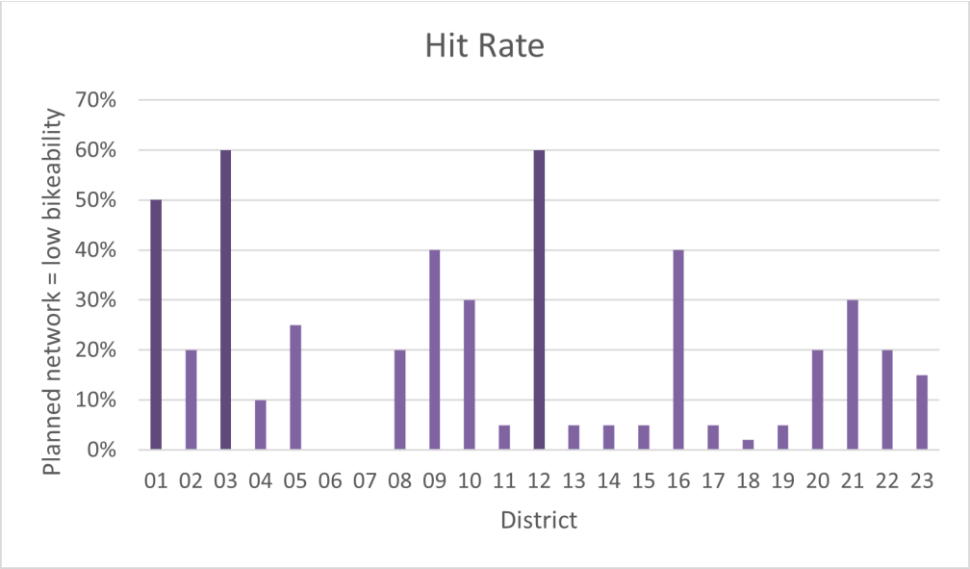

Figure 41: Estimated Hit Rate of NetAScore in Vienna

Figure 41 shows the results of the Hit Rate. The 12th, 3rd and 1st district have the highest hit rate. The results do not show why a district has a high hit rate or not. Further, it does not explain the reasons why the hit rate is low or high. To understand in what cases the NetAScore index worked well or not table 8 was conducted (chapter 8.4).

To calculate the segments with high potential, all segments classified as low bikeability and are not part of the main planned network (section 2) were analyzed with SVI for validity. Some segments were incorrectly classified, and not considered. After checking this, the streets that were left were measured and calculated together for each district. This resulted in a relative number of all streets with potential. To calculate relative numbers, it was set into relation with all streets per district (Share).

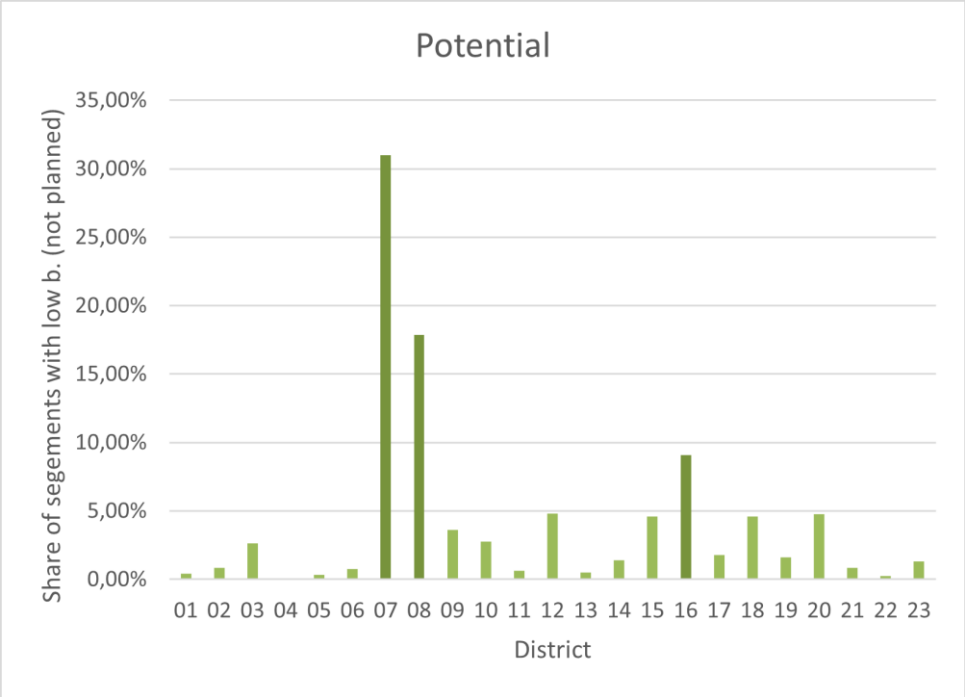

Figure 42: Potential as share of each district in Vienna

Figure 42 shows the results of the calculated potential per district. The 7th and 8th district show the highest potential. This correlates with the results seen in figure 41. Both districts are viewed more closely in the following figures.

For understanding the small scale results the 7th and 8th district will be selected and viewed at more closely. Further, part of the 10th district is depicted.

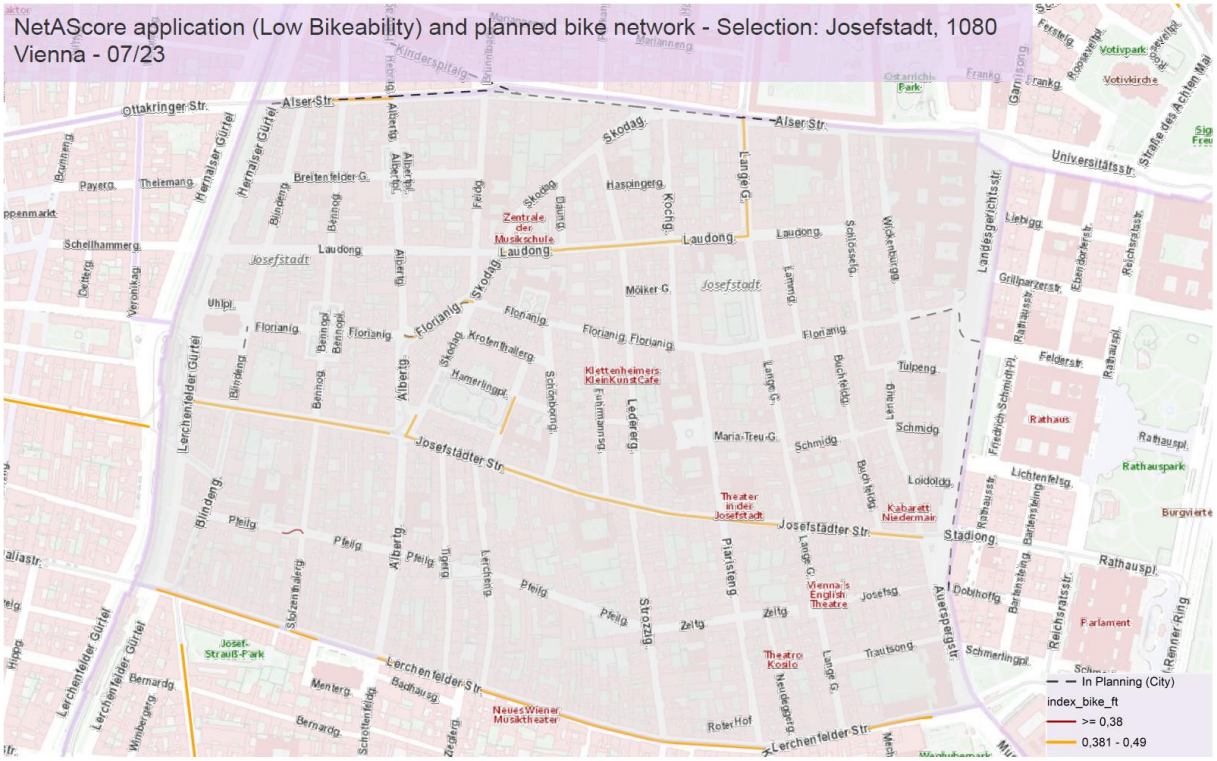

Figure 43: NetAScore Application 1080 Vienna

Figure 43 shows the 8th district with the NetAScore classification of low bikeability (orange) and the planned network (dashed). High numbers of potential, as described before, can be explained because some streets are major connecting routes between the inner and outer districts and are classified having low bikeability (Josefstädter Str., Lerchenfelder Str., Laudong., Lange G.). These streets are not part of the main cycling network and therefore not considered in the planning process. Still, the classification of these streets can be seen as a success of the NetAScore index. The low classification can be explained by the following reason. Neither Josefstädter Str. nor Lerchenfelder Str. have any bicycle infrastructure and the max speed is 50 km/h. Further, this can be seen by SVI, both streets have tram lines in both directions and parked cars on both sides (dooring zone) making it less secure for cyclists. The streets are not part of the cycling network because parallel to these streets there is a cycling axis called Pfeilgasse that connects inner and outer districts. Most cyclists use it for connection. Still, if not known, a cyclist will ride on the other streets with no bicycle infrastructure and therefore puts himself in danger.

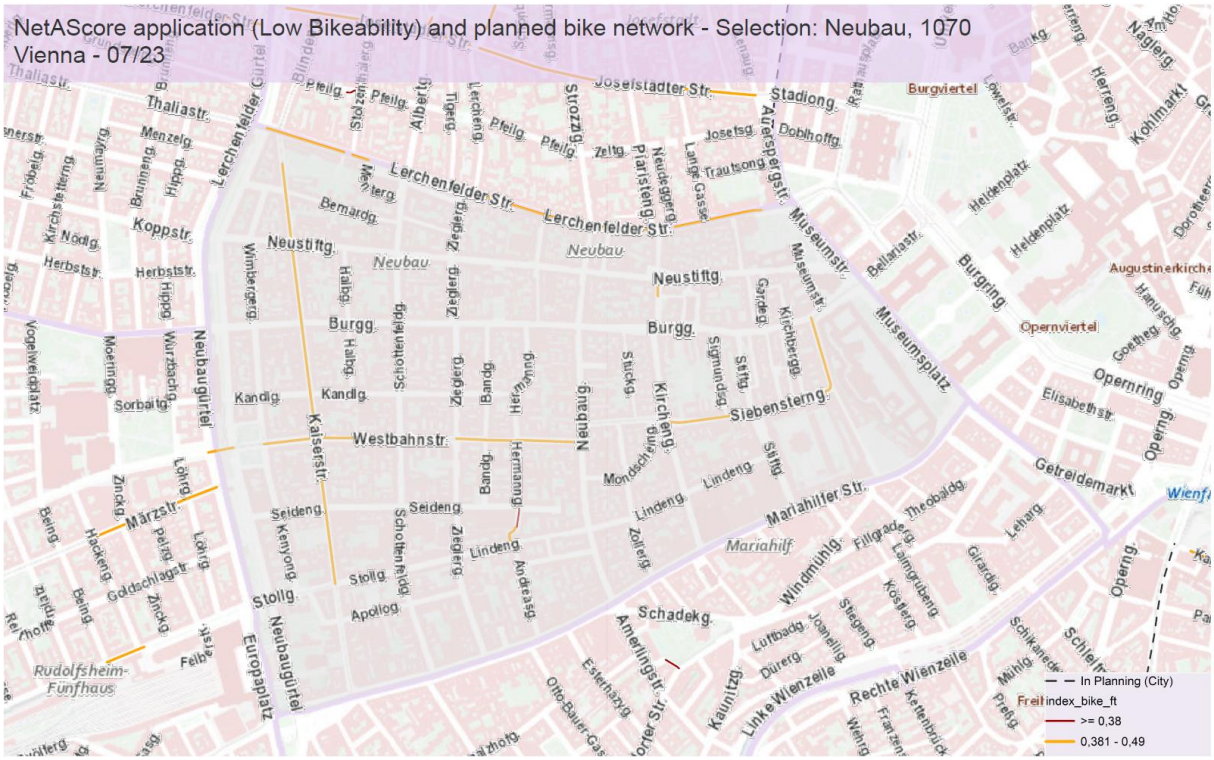

Figure 44: NetAScore Application 1070 Vienna

Figure 44 shows the 7th district in detail. Similarities to the 8th district can be found. Kaiserstraße is a main connecting route with cars at 50km/h and tram lines. Parallel cyclists can use Schottenfeldgasse or Zieglergasse for connecting the districts. Westbahnstraße is also classified as low bikeability and the same issue applies here. These results show that the NetAScore index can detect missing bicycle infrastructure and dangerous street segments that are not well equipped for cycling. Still, the index cannot consider other parallel running cycling infrastructure. It must be mentioned that the NetAScore index is a segment-based index, meaning that measuring bikeability does not consider the network around one segment nor the segment's structural meaning within a network. This would be a network analysis which is not part of this work.

Figure 45 shows a selection of the 10th district. If viewed more closely it can be detected that many streets that are classified as low bikeability are also part of the main planned cycling network. That means the estimated Hit Rate of this district is quite high.

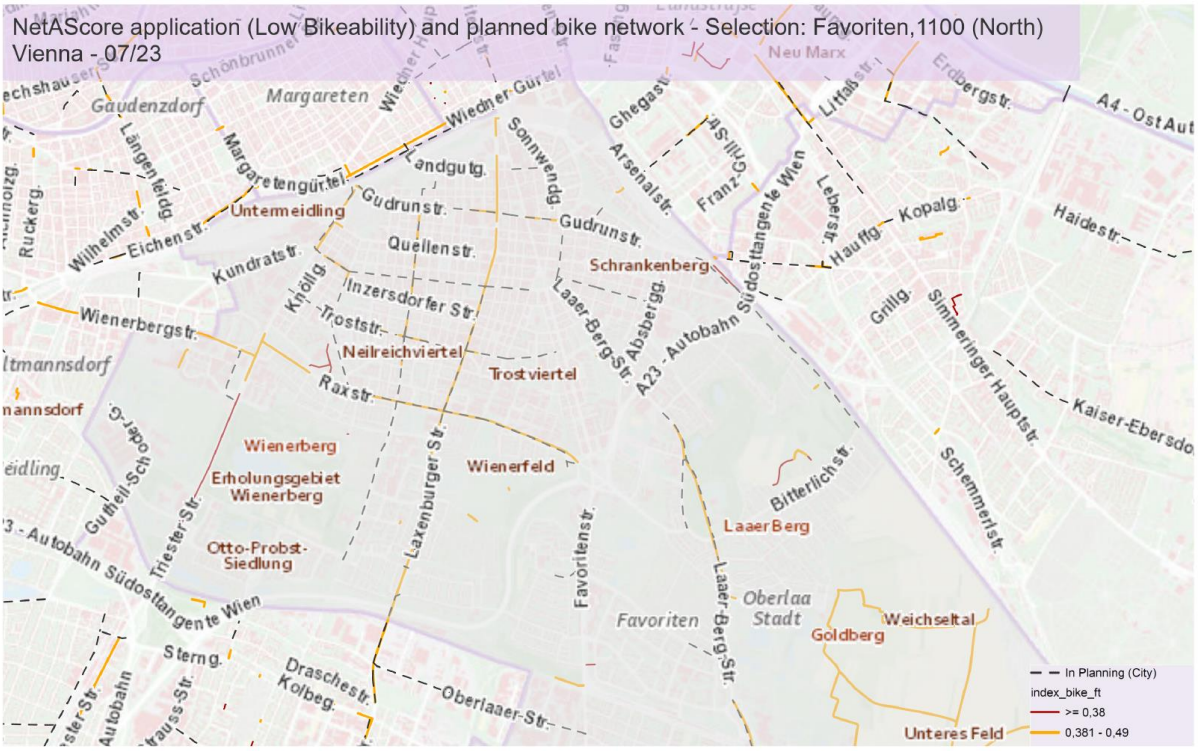

Figure 45: NetAScore Application 1100 Vienna

Another analysis looked at the segments classified as high bikeability (index values higher or equal to 0.57) and compared it with the existing cycle network. The result is a table with streets per district that should be improved in bikeability according to the index. Figure 46 shows an overview of all streets classified as high bikeability. Those streets were compared with the main cycling network that exists already (Version: 14.07.2023).

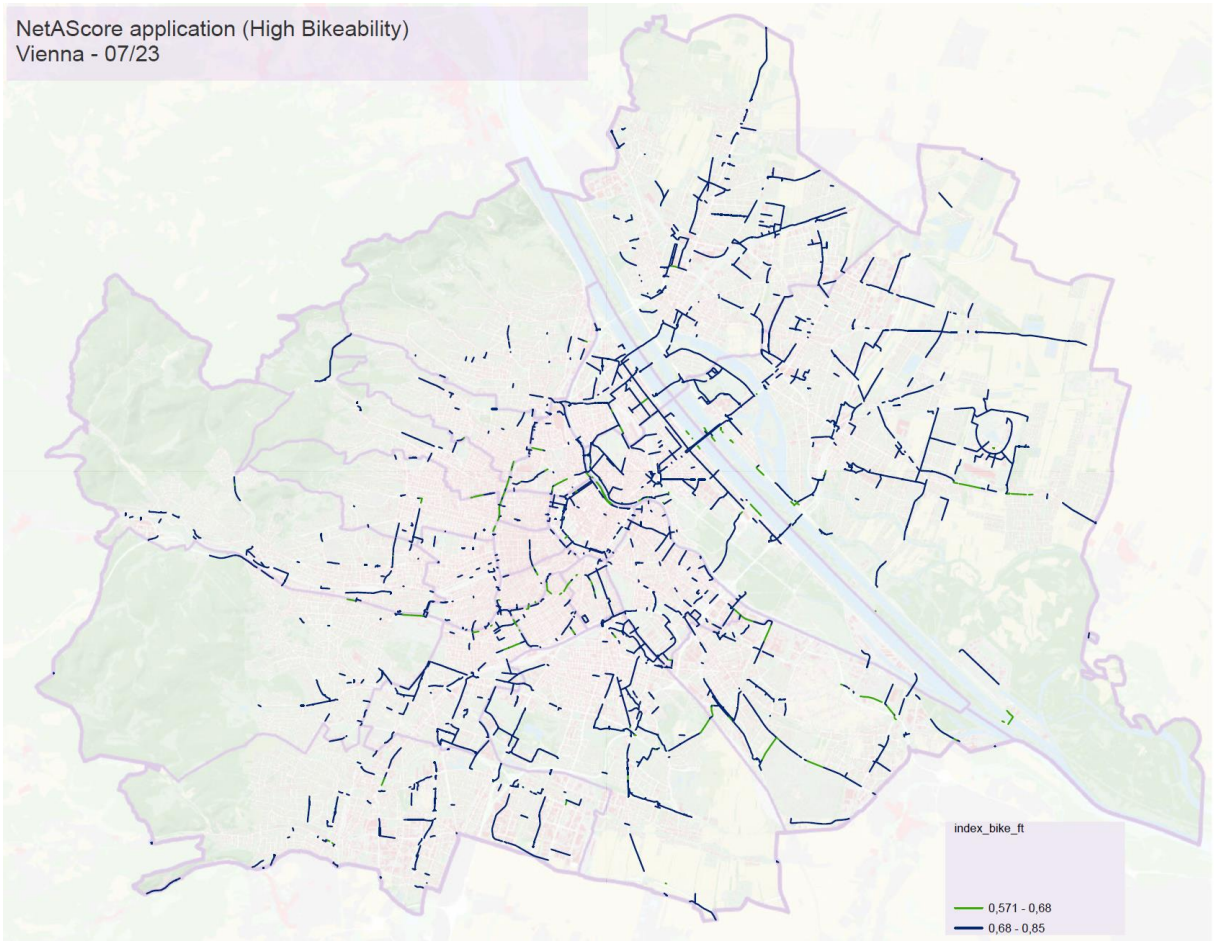

Figure 46: NetAScore Application High Bikeability

The result are two tables with different meanings. The first table shows all main streets that are classified as low in bikeability but are not part of the existing main cycling network. These segments should potentially be part of the network. The dataset can be expanded by those streets. The second table shows all main streets that are classified as low in bikeability that are also part of the main cycling network. These streets should be added to the planned network and considered when improvements to infrastructure are being made.

Table 6: Main streets not part of Cycling Network

Main streets classified as low in bikeability and not part of main cycling network	
1020	Taborstraße
1030	Ungargasse
1030	Fasangasse
1030	Rennweg
1030	Erdbergstraße
1030	Schlachthausgasse
1070	Kaiserstraße
1070/1080	Lerchenfelderstraße
1080	Josefstädterstraße
1100	Laabergstraße
1100	Grenzackerstraße
1100	Triesterstraße
1120	Wienerbergstraße
1120	Sagedergasse
1120	Edelsinnstraße
1150	Sechshauserstraße
1160	Neulerchenfelderstraße
1160	Thaliastraße
1160	Wilhelminenstraße
1160	Panikengasse
1160	Herbststraße
1190	Barawitzkagasse
1230	Breitenfurter Str.

Table 7: Main streets part of Cycling Network

Main streets classified as low in bikeability and part of main cycling network	
1060	Pilgrambrücke
1070	Westbahnstraße
1070	Siebensterngasse
1070	Breitengasse
1080	Laudongasse
1080	Lange Gasse
1110	Hauffgasse
1140	Breitenseer Str.
1150	Märzstraße
1150	Possingergasse
1160	Neulerchenfelderstr. 90-94
1160	Thaliastraße 146-158
1170	Mayssengasse
1190	Billrothstraße
1190	Silbergasse

8.4 Review of Analysis

These previous analysis shows that the NetAScore index can add information to existing planning knowledge and dataset. In the case of Vienna, streets were found that are not yet considered in planning processes nor are they part of the existing cycle network. Still, problems occurred when using the index. Table 8 shows an overview of commons problems that occurred during the analysis (evaluation: wrong classification, insufficient classification). As well as cases that performed well (evaluation: good classification).

Table 8

Review of common problems during spatial evaluation

Evaluation	Description	Example
wrong classification	Field paths/Forest roads near agricultural areas or forest classified as low	Goldberg Area (1100), Baumgartner Forest (1140), Donaustadt
wrong classification	Train stations	Praterstern (1020)
wrong classification	Cycling not possible (not allowed)	Handelskai (1220/1020), Klosterneuburgerstr., Wiedner Gürtel
wrong classification	Declared as cycle route, still low bikeability classification	Liesingbachstr., Nordbrücke connection
wrong classification	No path accessible (Private pedestrian way/through houses)	Pflege Simmering
insufficient classification	Bike lane seems to be classified better in bikeability than a traffic calmed area	Mariahilferstraße (upper segment vs lower segment)
insufficient classification	Bike path parallel (close by)	Amundsenstraße, Triester Str., Josefstädter Str., Kaiserstr.
insufficient classification	Only parts of street classified as low, although same conditions*	Can be found in every district
good classification	Bridge with many lanes and no infrastructure + in planning	Stanzenbergbrücke (1130)
good classification	Not in planning, no infrastructure, tram lines and dooring zone → high validity bec. it's detected by index	Reinlgasse (1140); Breitenseerstr. (1140)

Note. *more on this in chapter 9.1

8.5 Concept for Field validation

This chapter describes a concept for a potential field evaluation. Further research can be conducted by adding a field evaluation to the spatial evaluation of a bikeability index. By adding this qualitative method to the quantitative analysis, a more accurate result of the assessment study can be expected.

8.5.1 Study area selection

First, a representative area must be selected for analysis. In Vienna, this could be part of an inner district. In the 1st district there are areas where the pavement is not adequate for cyclists. This could be improved by field validation because this is not registered by the index. The 8th district can be used because tram lines partly go through cycle routes of the main cycling network. As tram lines are not considered in the index, the field evaluation could help.

8.5.2 Survey

A potential field review that establishes factors that cannot be measured by the index is not part of this work but can be the subject of further investigation. Generally, aspects that are categorized as subjective cannot be gathered with quantitative analysis. Subjective Aspects are hard to measure because you either need a lot of participants or only a small review that does not have a lot of meaning can be made.

In a study by Gullon et al., 2015 the M-SPACES score was listed. The metrics used in the M-SPACES audit tool (was used for physical and virtual auditing) can be used for a field validation. In table 9 the metrics that can be used in a field validation are listed. Some resulted from the M-SPACES scale. Further, the ACRES Scale was used to comprise field validation metrics (Wahlgren et al., 2010). Table 9 put together metrics that were not used by the NetAScore index and can therefore contribute to a more detailed result. Further studies can use this list and adapt it for other use cases.

Aspects that a field review can analyze are the following:

- Subjective measures: Attractiveness, Level of Stress
- Tram Lines: And quality along tram lines (Gaps between Lines and Pavement)

- Parked cars: Dooring Zone
- Tolerance of cars (how tolerant drivers are)
- Shadow/ Exposure to sun light
- Bad road condition: paved, but not even, holes

These can also be mentioned as limitations of the index. Integrating tram lines, parking zones or sun exposure can be aspects for future development of the index. In the case of Vienna, data of parked cars must be integrated in the analysis after calculating the index. Further this data is not publicly available. Tram Lines are openly available but also need additional analysis.

Table 9

Field evaluation metrics

Metric	Category	Scale	Evaluation method
Bike parking	Objective	Per Street	City of Vienna Map
Road condition	Objective	0-1	Physical Audit
Dooring zone	Objective	Y/N	SVI
Shared Mobility/ Bike	Objective	Per Area	SVI
Separation	Objective	Y/N	Physical Audit
Traffic lights for bikes	Objective	Y/N	Physical Audit
Tram Line	Objective	Y/N	Physical Audit
Attractiveness	Subjective	0-1	Physical Audit
Fume level	Subjective	0-1	Physical Audit

Note. Based on ACRES Scale, M-SPACES and expert interviews.

8.5.3 Analysis

For conducting a field review, tools like the Quick Capture tool by ESRI can be used. An ArcGIS Online account is necessary for using the app, students and researchers get a discount on it. First, a web map needs to be set up and published over the ArcGIS online account. The map should show a basemap with the Linestrings/highlighted street segments of the study area. Via the Quick capture app, the metrics can be used for data input fields.

The research question mentioned in chapter 3 asked what aspects can not be measured with the bikeability index but with the field validation?

Aspects like the metrics listed in chapter 8.5.2 cannot be measured with index and therefore results would achieve higher accuracy and detail when combining spatial analysis with the field evaluation.

9 Discussion and conclusion

This is the final chapter that puts together and discusses the results of the thesis as well as the limitations that occurred and that remain, the contribution to the research questions, further research gaps and concluding words on the thesis.

9.1 Results

The NetAScore index was viewed more closely in this thesis. This is the first thesis conducting an assessment of the toolbox NetAScore. Results apply to the study area of Vienna. The main takeaways from the assessment study and the usage of the toolbox conducted in this thesis are summarized by the following three criteria. Each critique is followed by a suggestion on how this problem can be improved. It must be mentioned that the version of the index used for this analysis is only targeted at a user group of experts since the index is at an early stage of development. The usability critique therefore must be understood with caution.

- Usability critique (main takeaways of using the toolbox)
- Technical critique (concerning results of the assessment)
- Practical critique (Experts opinion on the potential of the tool)

Table 10

Review of Index Assessment

Criteria	Description	Improvement
Usability	**Change Usage and Platform** The Terminal and the command line must be used (excludes certain users), few instructions and guides on usage and implementation.	The tool would have a greater reach if it was provided as an online tool with no local imports necessary (as *BikeScore*). A QGIS Plug in (as planned by the developer's team) would also exclude certain users. Videos or manuals on the usage of the toolbox would be necessary in addition.
	Availability of the toolbox Availability GitHub: Only researchers and technically affine people are familiar with it.	The tool is not promoted or cited in research papers yet. It is hard to know of, if not in this field of research. Promotion by other researchers and universities (scientific citations) is necessary. A homepage for the toolbox would help to promote it too.
	Change Local storage Importing Large Datasets locally	It is necessary to download large datasets for index calculation. This can be improved if the tool is available online because datasets can be on a server or directly torn from a website.
	Area selection in advance	Because imported datasets are quite big, the index takes a long time to calculate. This could be improved if the dataset can

Criteria	Description	Improvement
	Long waiting time for export	be somehow clipped in advance (GIP Data: selection of Area code in advance, for example)
Technical	**Data quality and latest data** Data quality is crucial, existing network and planned network could be integrated	Since the index result is always only as good as its input data it would be necessary to add additional administrative data when calculating bikeability.
	Different quality along one street	The index result shows different values of bikeability along the same street. One street can have different width or facilities along the route which results in different bikeability.
	Additional administrative data Tram lines and Dooring Zone should be rated low, Traffic calmed areas should count high, forest paths/agricultural path classified wrong	Tram Lines, Parked cars, Parking for Bicycles are all datasets available for the city of Vienna and need to be considered. Wrong or insufficient classification needs to be improved by editing settings for traffic calmed areas (Count them as high bikeability), and paths in the forest.
	Cycling Network Data	If the dataset of the city (Main cycling network) would be used for calculation as

Criteria	Description	Improvement
	Parallel Cycling routes not considered	well, cycling routes nearby could be considered when evaluating certain segments.
Practical	**Automated Process** How easy is the tool to use? Automation is necessary so that is does not create more work (And because of updates in data)	Experts suggest an automated process of calculation because otherwise more workload is created. Also, good usability is necessary. Automated data updates must be considered when the tool runs automatically.
	New unknown insights What results can the toolbox provide that planners not yet know?	The objective perspective on the traffic situation can provide important insights when debating with stakeholders. Having an overall result for every street for bikeability didn't exist before.
	Including more data GIP data: more elaborated data for a more detailed result?	Since the tool must provide information that experts don't know yet, datasets by the city as well as data by users (Radkummerkasten) must be included to get a more elaborated result.

Note. Based on expert interviews and spatial analysis.

As mentioned in table 10, there is a definitive potential for the Network Assessment tool and its usage in the administrative planning process. It is only a question of how easy it is to use it. The ability to run it automatically would be a benefit. It should not produce more work for the administration. Today, there is no such a tool in use for the city of Vienna as the experts told the author of the thesis. For meetings with decision

makers, it might be useful because there are sometimes heterogenous positions on the topic and the tool can provide an objective perspective to the planning process of cycling infrastructure in Vienna.

Generally, the experts see the potential of the tool. But data quality is crucial. If it's not always up-to-date and automated, it won't be very helpful. Since human resources are scarce, it should not create extra work. The GIP data is updated every 2 months, so it would have to be recalculated every 2 months. As a basis for meetings and to get an overall picture, the tool is helpful. One expert thinks it will probably uncover the already known problem cases but will not be able to show details.

From the technical point of view, a faster performance of the toolbox when working with large datasets of the GIP is necessary. Even though there are descriptions on GitHub on how to improve the performance of the tool, a more sophisticated technical set up is necessary for the tool to be used more often. This could be an online application as it can be seen at BikeScore (see chapter 4.3).

Results from classified street segments in Vienna on the one hand showed sufficient quality in classifying bikeability according to the measured Hit Rate. Some problems still occurred concerning classifying segments wrongly. On the other hand, results will always depend on the input data. For a more accurate result in Vienna, more data (Main Cycling Network, Parking spots for cyclists) is necessary. Since this data is not available for every other city, it may not be integrated into the tool. It can be concluded that if a bikeability index is created to evaluate any desired city worldwide it cannot be as accurate as specific local, administrative data or local knowledge of an area is.

9.2 Limitations

Limitations that were mentioned by other authors in previous studies concerning bikeability research and bikeability indices are described below. Later in this chapter the specific limitations of NetAScore will be explained.

Studies so far mainly focus on cities from the global and urban areas with high population density. This means that mostly cities with high quality bicycle infrastructure are examined because there is adequate data. In the future, studies with focus on different areas and a different focus on cyclists will be necessary to better understand the whole research field (Arellana et al., 2020). Further, conditions for cycling in the

USA or Canada are very different compared to European countries, so surveys from these countries have to be questioned and their results cannot be transferred directly to European cities.

Current literature is based on a small number of cyclists and correspondingly small data samples since cycling rates are mostly relatively low. Meaning the knowledge of cycling behavior and cyclists needs is based on a small group of the cycling population. This needs to be taken into account when analyzing previous studies on bikeability and cycling behavior (Muhs and Clifton, 2016).

A better and more systematic collection of data on cyclists' commuting trips and cyclists' levels is necessary. A standardized way of counting cyclists would also be helpful to gather data and analyze it. Demand can be better understood and investments could be better deployed (Buehler and Dill, 2016).

There is a huge number of studies explaining influential factors on biking. Due to the differences in data structures, availability and different conditions in each region the study's findings cannot always be compared and transferred to other areas. This makes the study field around bikeability complicated. Many indicators and metrics are developed in different regions than they are applied to. Because infrastructure varies between locations this can cause results that are not accurate enough to prioritize investments (Boettge et al., 2017). A more accurate analysis would be of the cyclists who are familiar with local conditions and who share their route choices. Since this data is lacking it can be seen as a limitation.

A limitation that affects every bikeability index is that it is impossible to integrate all influential factors of bikeability into one index due to different data quality and the fact that not every specific user group can be considered. Every index that has been reviewed in the literature and the NetAScore toolbox are proxies or models for bike-friendliness. It will always be an abstract model trying to depict and quantify reality as good as possible.

The limitations of NetAScore are described below.

The index is just a snapshot of time for the bikeability in Vienna. Older GIP datasets could be used to make a comparison of bikeability over time. The effect of

implementation of new infrastructure could be estimated by calculating the index before and after construction of new bike lanes or other improvements.

NetAScore can be applied worldwide, although a major downside that remains is that results depend on quality of the input data. In areas where OSM data quality is low or not consistent, the result may not be accurate. OSM data is not fully covering every city in detail which is why the transferability of NetAScore may be limited to urban areas of the global north. Since it is a global model, it cannot generate exact results for every area. A certain amount of fuzziness cannot be prevented. How to deal with incomplete data for network assessment can be the subject for further research. It can be mentioned as a limitation that the NetAScore index cannot be applied to every region without restrictions.

In needs to be mentioned that only three experts were interviewed for this thesis and therefore the results cannot be applied to every expert in that field. Other experts might have different opinions on the weighting of the metrics or the potential of the tool.

A tool that evaluates the importance of one segment for the whole network would be helpful in addition. With the calculation method of NetAScore single segments are evaluated without regard to their importance for the whole network. One segment can be low in bikeability but highly relevant for cyclists to reach a destination. The index only depicts information for the quality of single segments not for parts of the network.

It is hard to find data on used routes by cyclists. There are counting stations that count all cyclists passing by, but these are only placed irregularly and do not cover the entire area of the city. There is a lack of good data on cycling behavior for the study area. The NetAScore toolbox cannot provide insights on the directness of routes. It would be helpful to know what segments need to be improved to provide the most direct for cyclists.

As mentioned before some datasets that the city of Vienna publicly made available are not considered by the toolbox since this only applies to Vienna. Still, data on bicycle parking, dooring zone problems, traffic lights or the dataset on the main cycling network and its planned segments would mean a significant increase in the bikeability measure of Vienna.

Further, the traffic load of a street could improve results of the index. Since streets that are highly frequented by cars cause higher levels of stress for cyclists.

9.3 Suggestions on improvements

Improvements concerning the NetAScore toolbox were described in table 10 and explained in detail in this chapter.

Since the NetAScore toolbox is relatively new and has been released just 9 months before this thesis was written it is understandable that the toolbox is not technically and methodically complete. The toolbox is still under development and in constant adaptation. The suggestions on improvements aim to lead the developers of the toolbox into a user centered direction. Because this thesis used and evaluated the toolbox these suggestions developed out of practical experience with the tool and the opinion of experts with local knowledge.

The main critique from experts and from the usage of the tool concerns the usability of the toolbox. Since the only way to run the toolbox and calculate the index is with Python or Docker, meaning the command line needs to be used, it is not very user friendly. The toolbox is targeted towards researchers from other domains as well as public authorities and the public. It cannot be expected that these target audiences know how to use the command line or Python, even if it is only a few lines. An online application or a ready to use tool like a *QGIS Plugin* would be very helpful to solve this problem. Further, the needed datasets should not need to be imported by the user and stored locally. There are too many steps until the index results can be downloaded. This might deter potential users from working with the toolbox. If the aim is to establish the usage of the tool within the planning process for cycling infrastructure in the city of Vienna the tool needs to run as automatically as possible because it should not create extra work. Updates on the data need to be integrated automatically too. To establish wider awareness of the toolbox, a scientific publication in a paper or a scientific journal is necessary. Mentioned as a critique from experts was that additional datasets would be helpful to create a more detailed result of bikeability. These datasets can be administrative data like bike parking, tram lines, bike facilities like shops or repair stations as well as trees for shadow or traffic lights and their waiting time. Since these datasets only apply for the city of Vienna it would not improve the toolbox overall. It is hard to create an index that delivers good enough results for every use case. In the

case of Vienna, experts mentioned that the toolbox will probably not deliver information that is not know yet. It can only be used supportively for the planning process and to get an overview of a whole district for example. Problems that occurred in the bikeability result of Vienna, like the wrongly classified segments in the woods or pedestrian paths need to be improved. Also, a differentiation within the metric bicycle infrastructure would generate a more detailed result. Since experts mentioned that bicycle infrastructure can be of all different kinds (separated from traffic, mixed use with traffic or pedestrian, …) and therefore different experiences for cyclists occur, a differentiation within these categories is necessary. Physically separated paths and traffic calmed areas as well as bike streets should count more meaning influence the bikeability results more than a bike lane with mixed use. If this were the case, only streets with well equipped cycle paths (according to previously mentioned conditions) would have high bikeability. This dataset of routes with high bikeability can be the basis for a new cycle map as it was criticized that there does not exist a cycle map for Vienna.

Improvements that need to be made for cyclists in general are explained below. These improvements concern cycling infrastructure.

As previous studies found out when analyzing the travel behavior of cyclists, fewer junctions, redlights, stop signs and inclines are preferred by cyclists and therefore should be considered. Green spaces and bicycle infrastructure have been shown to be preferred by cyclists when selecting their route. Generally, the more segregated the infrastructure is from cars and traffic the more attractive it is for its users. Policy makers can also have an impact by applying push methods like car parking regulations (McArthur and Hong, 2019).

In Vienna, experts mentioned that there is a need for better guidance, meaning better signs on the streets for cyclists. These signs should provide information on where the next cycle route is and how to get there. This would hinder cyclists from taking routes that are not part of the main cycling network and therefore don’t have adequate infrastructure. As this can be seen in Vienna, it is sometimes the case that bike paths dedicated mainly to safe and fast commuting for cyclists often are parallel, one block away from major connection routes for cars. For people who are not familiar with the localities signs or guided routes would be helpful to avoid major car roads. In Vienna this is the case with Hasnerstraße being a bike street connecting outer districts with

the connecting main cycling route on Gürtel. It flows parallel to roads without any cycling infrastructure. Also Pfeilgasse, which connects the ring with the Gürtel is heavily used by cyclists because they have priority and its well equipped. Parallel is Josefstädterstraße and Lerchenfelderstraße that have a speed limit of 50km/h and tram lines as well as parallel parking, all being hazards for cyclists. Directing cyclists to streets with good infrastructure or lower speed limits therefor may be more sensible than investing in infrastructure elsewhere (Boettge et al., 2017).

9.4 Contribution to research questions

Objective 1 Analyzing local conditions of the study area.

Research Question 1 What background local knowledge can experts on bikeability and urban planners reveal regarding aspects of Vienna's bike network and the planning process that have not yet been scientifically examined?

As three experts from different domains were interviewed for this thesis some insights into the planning process in Vienna, estimations on the potential of the toolbox as well as local problems within cycling infrastructure were given. The administrative structure of the City of Vienna and the responsibilities of each player for the process of urban planning for bicycles was explained. Experts mentioned problems that occur during this process, such as political issues, scarce personal resources and issues like one-way openings for cyclists that are not sufficiently established. The potential of the NetAScore toolbox was generally rated high though there was some critique. The toolbox can provide an overview of a big area and deliver an objective image of bikeability of the city. This can help make the meeting for planners more efficient because it leads to fewer discussions. Experts also rated what factors are most important when calculating bikeability in Vienna. The existence of bicycle infrastructure was rated as being very important, along with the speed limit for cars, the street width, the pavement and the number of crossings and buildings within an area. Generally, the interviews with experts on that topic were crucial for understanding the conditions in Vienna, the problems in the planning process and the major issues within the cycling infrastructure of Vienna. There is little examination of Vienna's bike network that is published scientifically since planning details and the workflow within city departments is often politically sensitive. This work describes how different players interact with one another and what factors influence cycle planning most. It has to be mentioned that

there is no general explanation of how the planning process runs, since a lot of different aspects like political decisions and priorities or technical issues play together and differ from location to location. At the time of writing this work, there is no other paper or public thesis that analyzed Vienna's Bike Network with the NetAScore index and further discussed the planning process for cycling infrastructure in detail with the relevant players.

Objective 2 Assess the NetAScore index with related data sources and a field review.

Research Question 1 What is the spatial variability when measuring bikeability with the NetAScore index in comparison to other available and relevant data in the city of Vienna?

The NetAScore toolbox provided a dataset with the street network of Vienna and its rating in bikeability and walkability. Street segments were rated from 0 to 1 and the calculated bikeability was visualized on different maps showing different areas. The highest share of low bikeability (below 0.49) measured for each of the 23 districts of Vienna was in the 7th, 8th and 17th district. The highest share of high bikeability (above 0.57) was measured in the 1st, the 4th and the 20th. Low bikeability also includes roads in the forest and agricultural roads and some pedestrian ways that were classified incorrectly. The measured bikeability was compared with the official main planned cycling network of the City of Vienna to calculate a Hit Rate and find out streets with High potential for improvement. The 7th and 8th district as well as parts of the 10th district were looked at more closely and results were explained according to these districts. The measured bikeability was further compared to the main cycling network and streets that are low in bikeability and part of the network were extracted and listed. These streets should be further improved according to the toolbox. Further, streets that are not part of the network and are low in bikeability were extracted to provide potential streets that should be included in the network. The spatial variability therefore can be explained by different extractions out of the dataset that explain segments that should be improved, should be part of the network or have high potential for improvement. A list in the appendix shows detailed results for every district. Further, to understand how the toolbox performed, a review of problems that occurred and insufficient classification that happened, was put together. These results most likely can be transferred to other research areas where the toolbox was used.

Research Question 2 What aspects of bikeability can a field review-based analysis of a selected region of Vienna consider compared to the index-based analysis NetAScore?

The field review was not conducted in this thesis. Still, a concept for a field evaluation was explained and further metrics that cannot be measured with the NetAScore toolbox were described. The list of metrics was conducted based on literature (previous field evaluation metrics). All subjective metrics like attractiveness of a surrounding or the level of stress a cyclist experiences cannot be measured by a toolbox. Further, the quality of pavement, the dooring zone, tram lines as well as parking facilities for cyclists or sun exposure can be measured with a field review but not with the NetAScore toolbox. Generally, using both quantitative and qualitative methods for evaluating a topic leads to more accurate results. Therefore, conducting a field review in addition to other methods can be recommended when analyzing a bikeability index.

Research Question 3 What improvements can be made to the NetAScore index based on the findings of a field review, qualitative interviews and a quantitative assessment?

Results from the expert interviews and spatial analysis resulted in a detailed list with all major critique points and a suggestion on how these points can be improved. To sum up, usability issues were mentioned most by experts meaning improvements in usability of the product is necessary. An online tool or a Plugin are highly recommended so that interested people can use it easier. Using the command line, importing software and large dataset are deterrents for users and need special knowledge. A more detailed guide on how to use the toolbox, maybe with the support of small videos would be necessary. To increase the scope of the NetAScore toolbox, publication in different scientific journals and promotion for the tool in the public sector of different cities in Austria is recommended. For a wider usage in the planning process, the tool needs to be able to integrate more locally specific data as explained before. Concerning the used metrics, the metric bicycle infrastructure is very important for the result of bikeability and should be developed further. It must be distinguished between bike infrastructure that is safer than other. Therefore, physically separated bike paths, bike streets and traffic calmed areas count more than mixed traffic or bike lanes. This is necessary for getting a more accurate result.

Radlobby Vienna has an online tool where citizens can enter problem areas and zones for cyclists. The dataset is highly relevant because local knowledge can improve the overall result of bikeability. Street segments where users commented often should be considered in the overall result of bikeability. This could draw a more accurate result.

Data that shows cyclists' trips within the city is lacking but improves the understanding of important segments and areas within the network of cycling infrastructure and would highlight gaps in the network. The city's strategy so far, improving the cycling infrastructure based on the counting station data, is probably not always targeting the right zones. The NetAScore toolbox can provide another data source for decision making and support the planning process in Vienna. Still, improvements should be made to deliver a result that better reflects local conditions.

9.5 Further research

Based on the results of this thesis future research should focus on not only analyzing urban areas with high population and building density with the toolbox but also suburban and rural areas. This might lead to different results and can give more insight into the functionality of the toolbox.

It would be interesting to compare results of the NetAScore toolbox in Vienna with cities like Copenhagen or Amsterdam, that lead the way in bike favoring policies and investments. Further, a city in the US with different conditions than in western Europe would be interesting to compare too and can be the subject of further research.

Comparing the index before and after investments and changes in infrastructure have been made would be best to understand how reliable the results are. For further analysis, a timeline of changes in bikeability would be interesting and helpful to have. Calculations would need to be made with the same toolbox and the same weighting of components to have adequate results. For this thesis historic data would be necessary to compare bikeability results. Further, the relationship between bikeability and walkability results of the NetAScore toolbox need to be examined further to better understand their relationship and the index results.

Certain research gaps are resulting out of this thesis. Further application of the NetAScore toolbox to other areas outside of Austria is necessary. Comparing Austrian cities with each other can be another future research field. The comparison between

OSM data and GIP data for the NetAScore calculation can provide important insights. Creating user profiles for different bike users and comparing results can be considered as well. Generally, more published papers and other relevant actors are necessary to help establish higher popularity of the NetAScore toolbox. To be cited by other studies, the toolbox first must be published in a paper of a related field with results and user testing (Kellstedt et al., 2021). Otherwise, it will not be considered as a bikeability measurement because you can't find it when researching previous literature.

Enhancing the NetAScore toolbox, making it available on a web-based platform online and improving it by the mentioned suggestions can be the basis for future research.

The question whether high bikeability (according to the index) can predict high bike usage can be the basis for further research. This is out of the scope of this thesis. Further, there is a lack of research in understanding to what extent cyclists are influenced by bikeways and what reasons cyclists personally have for using the bike in the city of Vienna. It needs to be studied what effect shared lanes with bus and bike have and how bike boxes and separate signals affect cyclists' behavior. Future work could further focus on measuring the bicycle demand and the expected cyclist flows to decide and target infrastructure investments.

The opportunities citizen science can bring into the field of bikeability research need to be examined in future research. Participative approaches like *Mapathons,* where citizens draw a map of a desired bike network together, can be applied.

9.6 Conclusion

This thesis is in line with previous studies identifying the importance of good quality cycling infrastructure and its effects for the cycling mode share in Vienna. This thesis has the overall aim to promote cycling as a healthy, climate neutral way of commuting in urban areas. The advantages of cycling for society and the environment were explained. Using the bike can be seen as a socio-cultural phenomenon, a way of living, a certain lifestyle. It is not only about getting from a to b. Cycling has the potential to become the most used transportation mode in cities (Schmid-Querg et al., 2021). More space is needed for active mobility at all levels, both in the built environment and in legal texts. The underlying question is what can be done to increase the number of cyclists in cities. For a safe cycling experience adequate cycling infrastructure is

necessary. To measure how safe a city and its cycling is, bikeability indices can be a tool to measure that. This thesis gave insights into previous research on bikeability studies and its field of research. Further, it was explained what factors make a street network highly bikeable and attractive for cyclists of all kinds. International best practices were listed to explain what cities can do to improve cycling infrastructure and increase cycling rates. The focus of the practical part of this thesis was the toolbox NetAScore and its evaluation based on the city of Vienna. The toolbox and its functionality were explained. Interviews conducted with experts set the base for understanding local conditions in the study area and evaluate the potential of the NetAScore toolbox. After calculating bikeability for Vienna the results were compared with other data sources. The results showed that the measured low bikeability is partly covered by the main planned cycling network of the city meaning that results by the toolbox can improve the planning process. An estimated Hit Rate was calculated for each district to show to what extent the toolbox results overlapped with the planning dataset. A table with all streets that should be improved according to the index resulted. Finally, suggestions for improvements were conducted analyzing aspects of usability, technical issues about the toolbox as well as its practicability. Generally, the practicability of the NetAScore toolbox is not that high yet. This emerges because of the usability issues mentioned above as well as the practical critique by the experts. Still, the toolbox and its utility as a planning tool is of high importance. It can be used to lead investment projects, for research purposes and to engage the public.

Overall, the toolbox is a great tool for researchers or students from the field of transport planning, GIS and other related fields with a technical background to evaluate a street network of a desired location. Since advanced computer skills and insight into GIS data is necessary to use and understand the toolbox, the general public might not be able to use the tool. For the public sector that is in charge of planning cycling and walking infrastructure of a city, the toolbox and its result provide an overview of bikeability and walkability results of a city. This can be helpful at meetings with different players and to get an objective result of the measured street network. For a wider usage of the tool, it needs to be available online with no need to install data or software. For a more detailed result that can locally improve infrastructure planning a few adaptations need to be made as worked out in this thesis.

In Vienna, public transport is used by 30% for commuting as of 2022. 26% use the car. The aim is to address people who use the car for commuting in the city and in daily life. Improving cycling infrastructure can be one solution to get more people to cycle. Further, political will must exist. Campaigns, incentives and other Push and Pull Factors are needed to make mobility with the car less attractive. Cycling also must be thought of as more multimodal, meaning combining cycling with public transport. Bike sharing must be more recognized in the planning process and should be seen as one form of mobility as well (Muhs and Clifton, 2016).

If the use of bicycles as a means of everyday transport is widely established, then in addition to improving public health, significant improvements in the environmental situation of cities can be expected (Meschik, 2008). There are many factors that influence cyclists' behavior and the modal split. A bike friendly environment meaning adequate infrastructure is one factor, but implementing policies simultaneously with car reduction policies is necessary as well. There is evidence that more people are interested in cycling than do cycle, meaning they are concerned about safety and other restraints. By targeting incentives to this group, higher cycling rates can be reached (Hardinghaus et al., 2021). The promotion of cycling as a means of transport is an issue that affects many sectors. Alliances between transport, health, urban planning, sport and education increase the chances of cycling becoming a dominant mode of transport.

As an experienced cyclist who commutes in Vienna daily, I found it encouraging to write this thesis because I was always confronted with cycling and issues concerning urban environment during the period of research for my thesis. When riding home or to destinations I got new ideas for the thesis and could test my knowledge in real life by biking in the city and being attentive.

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10.3 Tables

10.4 Figures

11 Appendix

11.1 Survey Design Interview

Master thesis title:
Measuring the bicycle friendliness of the city of Vienna using the NetAScore toolbox for sustainable mobility. A quantitative assessment and qualitative review of the index tool.
Author:
Johanna Karl, BSc
Supervisor:
Ass.-Prof. Dr. Ourania Kounadi, BSc MSc
Date: 25.04.2023

Underlying Objective for the interviews:
Analyzing local conditions of the study area regarding aspects of bicycle friendliness
Research question aiming to solve with interviews:
What background local knowledge can experts on bikeability, and urban planners reveal regarding aspects of Vienna's bike network and the planning process that have not yet been scientifically examined?

Aims:

- Getting practical input of people from the field / with expertise concerning factors that are not mentioned in the literature for example about the planning process in Vienna.
- Getting information about special conditions regarding cycling in Vienna.
- Aim is not to have a representative number of people filling out questionnaires rather selected professionals that help with extra information.

Schedule:

1. Get in contact - April
2. Get feedback
3. Meet - May
4. Transcript all - May
5. Select important parts - May
6. Translate - May

Form:
Open questionnaire
Contact:
Via Mail primarily and if necessary, by phone
Language:
German, translated to English later.
Record keeping:
via tape recording over Phone and/or handwritten transcript (ask for permission in advance)
Time limit:
12 min.
Time period:
The interviews will take place in the period of April – June 2023.
Theory:
The expert interview is a qualitative survey method, aiming to describe, interpret and understand facts and contexts. Qualitative interviews are well suited as preparation for quantitative surveys (or other quantitative analysis) which happens later in the thesis.
The responses of the experts will be summarized and analyzed by means of topics and relevance for the thesis. Depending on the quality and extent of the content the answers will be described in a separate chapter or fit into the existing text.

Sent to interviewers in advance:
short description of topic and reason for interview and approx. questions, time length of questionnaire, consent to use their answers for your research, ask them for name disclosure consent as well, indicate your plans about storing the data and publishing research results.

Questions:
Introduction of the interview with short description of the topic and what I am expecting from the interview. (partly adapted for each contact)

- Für welche Bereiche der Radverkehrsplanung sind Sie zuständig?
  Which area of cycle planning or coordination are you responsible for?
- Welche Verkehrsmaßnahmen erachten Sie in Zukunft als besonders wichtig für den Radverkehr in Wien an?
  What measures do you consider to be particularly important for cycling in Vienna in the future?
- Welche Probleme sehen Sie in der Umsetzung oder Planung von Radwegeinfrastruktur in Wien?
  What problems do you see in the implementation or planning of cycle path infrastructure in Vienna?
- Welche Datengrundlagen haben Sie, um den Radverkehr zu messen und dem Bedarf an Radwegen an den richtigen Orten gerecht zu werden?
  What data do you use to measure cycling traffic and meet the need for cycle paths in the right places?
- Wie wichtig schätzen Sie die folgenden Faktoren für den Radverkehr in Wien ein? Bewerten Sie deren Relevanz indem Sie es einzeichnen (siehe unten).
  How important do you consider these factors for cycling in Vienna? Evaluate the importance by drawing it.
- In welchen Teilen Wiens funktioniert ihrer Meinung nach das Radwegenetzwerk gut? Welche müssen verbessert werden?
  What area do you think the bike network works well? What areas need to be improved most necessarily?

Outcome/Expected Results:

- What data is being used to prioritize cycling infrastructure investments.
- Who is responsible for what part of the planning and coordination process in Vienna.
- How do different experts see the future of cycling numbers in Vienna.
- Getting ranked factors of priority for the index.

List of possible Experts (priority ranked):

Name	Organisation	Relevance	Mail address
anonymous	City of Vienna	Head of Planning; Smart City Concept, Bike Coordination	post@ma18.wien.gv.at
anonymous	Mobilitätsagentur City of Vienna	Head of Cycling and Walking Issues	office@mobilitaetsagentur.at
Roland Romano	Radlobby Österreich	Federal Association of cyclists interest	info@radlobby.at
Michael Skoric	Consens Mobility Planning	Talk at Radkompetenz, part of new StVo	skoric@cvp.at

Katharina Drage	Rosinak und Partner	Planning and Consulting, ZGIS	drage@rosinak.at
Ulrich Leth	Platz für Wien (NGO)	Scientist and Protester for more public space and slow mobility (won prices)	ulrich.leth@tuwien.ac.at
Valentin Brunner	City of Vienna	MA28, Planning Cycle Paths Intern	valentin.brunner@wien.gv.at
Lina Mosshammer	VCÖ (Traffic Club)	NPO	lina.mosshammer@vcoe.at
Iris Ehrnleitner	BMK (Ministry for Climate, Traffic, Technology)	Klimaaktiv Mobil Initiative	iris.ehrnleitner@bmk.gv.at

Note. Not everybody was contacted. Anonymous: Person did not want to be named.

11.2 Interview 1: 13.06.2023: Survey, Transcript, Handout

Interview 1: Survey

Wien, 13.06.2023

Interviewerin: Johanna Karl, Studentin Masterstudium Kartographie und Geoinformation

Interviewter: anonymous

Dauer: 40 min.

Thema: Messung der Bikeability (Fahrradfreundlichkeit/Tauglichkeit) der Stadt Wien mittels der NetAScore Toolbox im Rahmen einer Masterarbeit

Ablauf:

1. **Vorstellung (Recording, Anonymität?)**
2. **Intro Masterarbeitsthema**
3. **Ziele**
4. **Fragen**

- Für welche Bereiche der Radverkehrsplanung oder Koordinierung ist die Mobilitätsagentur zuständig?
- Welche Datengrundlagen haben Sie, um die Planung von Radwegen an den Bedarf anzupassen? (Messung des Radverkehrs)
- Welche Maßnahmen sehen Sie in Zukunft als besonders wichtig für den Fahrradverkehr in Wien an?
- Welche (strategischen) Probleme sehen Sie in der Umsetzung oder Planung von Radwegeinfrastruktur in Wien?
- In welchen Teilen Wiens funktioniert ihrer Meinung nach das Radwegenetzwerk gut? Welche müssen verbessert werden?
- Wie schätzen Sie die Chancen des Tools ein (für eine Anwendung in der Praxis?)
- Wie wichtig schätzen Sie die folgenden Faktoren für den Radverkehr in Wien ein? Bewerten Sie deren Relevanz, indem Sie es einzeichnen (siehe unten).

Interview 1: Transcript

Interviewte Person: anonym, Teilorganisation der Stadt Wien

Johanna Karl: Autorin

Johanna Karl Also vielleicht kann ich zuerst etwas über mich erzählen, dann ist der Kontext klar. Ich studiere Kartographie und Geoinformation. Und ich mach das mit der Universität Salzburg zusammen, die Masterarbeit. Ich habe mich mit denen getroffen, weil die haben ein Tool entwickelt, das nennt sich Network Assessment Tool. Das macht auf Basis von entweder GIP Daten oder OpenStreetMap Daten, je nachdem wie man es möchte, einen bikeability oder walkabilityindex für jedes Straßensegment. Das kann man eigentlich weltweit je nachdem, also wie man will, weltweit anwenden. Noch ist es so ein GitHub Tool. Also da muss man sich schon ein bisschen programmiertechnisch ein bisschen auskennen, weil es dann in einem docker Container rennt. Also dann muss man sich das aufsetzen. Aber im Prinzip ist es so angedacht, dass das häufiger verwendet wird. Das ist aber erst seit einem Jahr überhaupt verfügbar online. Und meine Idee war es halt, das Tool zu testen, wie gut das funktioniert und wie sehr das auch mit der Realität übereinstimmt überhaupt. Also es ist klar, es ist ein Modell. Ich habe auch Karten mitgebracht. Kann man sich das vielleicht bisschen besser vorstellen? Also ich habe da erst mal nur die ersten Berechnungen gemacht. Das ist noch nicht sehr ausgereift, aber es gibt zum Beispiel, das ist auf Basis von GIP Daten, das auf Basis von OSM. Sprich die Datensätze unterscheiden sich schon mal ein bisschen und dann geht es im Prinzip einfach darum, eine Skala von 0 bis 1, die jedes Segment eben aufgrund von unterschiedlichen Kategorien, zu denen komme ich dann noch, bewertet. Und ja, es soll, es kann als Planungstool dienen. Ich habe mir das auch schon angeschaut. Es ist nicht immer schlüssig, weil ich meine, ich kenne das Gebiet ja auch. Du ja auch.

Interviewte Person Also die Hollandstraße ist niemals so gut befahrbar wie der Donaukanal.

Johanna Karl Und da ist eben dann die Frage, auf welche Faktoren es basiert, was man sich anschaut, zum Beispiel.

Interviewte Person Die Tabor Straße ist nicht schön zum Fahren.

Johanna Karl Ich finde auch ja, wenn man zum Beispiel die Basis nimmt, also das die Infrastruktur, die Radinfrastruktur extrem wichtig ist für die Berechnung, dann adaptiert sich das ganze. Also man kann dann eben so Gewichtungen legen auf die einzelnen Werte. Das ist mal so der Kontext. Und ähm, ja, mit meinen Interviews, das war eine Idee von meiner Betreuerin, um einfach das qualitativ noch mal besser zu umfassen und eine Idee zu bekommen, wie das in Wien bis jetzt funktioniert und auch einfach die lokalen Gegebenheiten ein bisschen besser verstehen. Also es ist wirklich auch nicht lange angedacht, das habe ich schon gesagt, so 10- 15 Minuten vielleicht. Weiß nicht genau, wie lange deine Antworten sind, aber so in die Richtung.

Interviewte Person Ewig, können Sie sein.

Johanna Karl Nehme ich an, Aber ja. Genau. Also, hast du das verstanden?

Interviewte Person Ja.

Johanna Karl Okay. Hast du Fragen?

Interviewte Person Nein, Ich bin sehr gespannt auf das Ergebnis. Also, es gibt natürlich auch Studien, die die TU hat, mal quasi die ganzen Gehsteigbreiten in Wien erhoben. Und das ist natürlich schon spannend. Also auch die Frage, wie systematisch Informationen und Daten bereitgestellt werden können und ob man damit arbeiten kann.

Johanna Karl Ja genau, die GIP Daten bieten da schon mal, finde ich, eine sehr gute Grundlage. In diesem Kontext. Ich würde auch gern dann später noch wissen, ob das Tool überhaupt in der Planung Chancen hat. Ob das sinnvoll ist, deiner Meinung nach, sozusagen

einfach dein Bauchgefühl? Es ist ein qualitatives Interview, es geht nicht so konkret um genaue Zahlen oder so. Ich habe ja schon ein paar Fragen im Voraus geschickt, es sind prinzipiell die selben.

Interviewte Person Ja, gut.

Johanna Karl Passt gut. Also, zum Kontext. Für welche Bereiche seht ihr euch zuständig? Seid ihr zuständig?

Interviewte Person Wir sind ja quasi koordinativ zuständig. Koordinativ bedeutet, dass wir einerseits diesen Erarbeitungsprozess organisieren und dann auch begleiten. Weil es verschiedene Stellen gibt im Apparat, im Magistratsapparat der Stadt Wien. Es gibt strategische Stellen, das ist ungefähr die MA18, dann gibt's die Planungsstelle, das ist die MA18, teilweise auch MA46. Und dann gibt es die, Baurealisierung und dann die Verordnung, also auch wieder MA 28 und MA 46. Dann gibt es noch verschiedene andere Dienststellen. Das möchte ich jetzt nicht weiter ausführen, weils sehr viel ist. Und dann gibt es eben Bezirksebene, es gibt die politische Ebene, die Stadtpolitik, das sind zum Beispiel Stadtviertel. Und zwischen diesen verschiedenen Ebenen versuchen wir erst einmal quasi einen Prozess zu organisieren. Und wir kommen regelmäßig auch zusammen, fordern den Austausch zwischen den Dienststellen, versuchen so die Knoten auch ein bisschen zu lösen. Hier und da, Knoten passieren einfach. Wir versuchen natürlich auch, ein bisschen Struktur in diesen Prozess reinzubringen, so dass man das strategisch angeht. Und andererseits sind wir aber eben im Rahmen dieser Koordination auch Schnittstelle, eben nicht nur zwischen den Dienststellen, ganz stark aber auch zu den Bürgerinnen und Bürgern und dann auch der Zielgruppe draußen, die eben Rad fährt. Bedeutet also dort gibt es einen starken Austausch. Wir machen nicht nur die klassische Öffentlichkeitsarbeit, wir beantworten auch die Fragen. Wir stehen auch im Austausch mit den Lobbyorganisationen und tragen das dann wiederum auch zurück ins Magistrat oder zur Politik und versuchen so wirklich, möglichst integriert zukünftige Projekte dann aufzusetzen oder anzugehen.

Johanna Karl Das heißt konkret, wo etwas stattfindet, wo eine neue Infrastrukturanlage geplant ist, zum Beispiel, wenn es da Vorschläge gibt von der Bevölkerung oder so – wie funktioniert dieser Prozess?

Interviewte Person Na ja, also wir hier bei der Stadt wissen relativ gut in etwa, wo Löcher sind. Es gibt ja einmal das Hauptradverkehrsnetz, das ist quasi unser Grid, auf dessen Grundlage wir im Endeffekt arbeiten, weil all das was nicht im Hauptradverkehrsnetz ist, ist zwar für uns durchaus relevant oder von Interesse, ist aber in Bezirkskompetenz. Also das heißt initiativ kann man natürlich den Bezirk auch ansprechen, und sagen, he wie schauts aus, aber prinzipiell, wenn es um Planung und dann auch Bedeckung und Ausführung geht, ist es halt einfacher im Hauptradverkehrsnetz zu bleiben. Und da gibt es natürlich schon, das führen wir ständig mit, die Überlegung, was entspricht wo jetzt nicht mehr dem technischen Standard oder wo gibt es vielleicht gar nichts als Grundlage? Bedeutet also wo ist der Handlungsbedarf einerseits am größten und wo ist dann andererseits aber das Potenzial an Nutzerinnen und Nutzern am größten? Und wir haben uns das unter diesem größeren Gesichtspunkt mal angeschaut, um dann eben für uns den Fahrplan zu machen, also Projekte. Und das wird dann verschnitten mit verschiedenen anderen Projekten. Wo werden Leitungen erneuert, wo erneuern die Wiener Linien ihre Schienen, gibt es verschiedene andere Programme der Stadt Wien und manchmal gibt es dann eben dieses Window of opportunity und dann nutzen wir das.

Johanna Karl Okay, ist klar. Zweier Linie, ich bin schon gespannt. Also weil du gesagt hast, das Potenzial messen auf Basis von welcher Grundlage wird das mit Befragungen gemacht oder nur mit den Zählstellen?

Interviewte Person Also wir haben unsere Zählstellen, die sind unsere Datengrundlage und über diese Zählstellen hinaus gibt es 4 bis 6 Erhebungen noch abseits der Zählstellen. zu erstellen. Das passiert dann einfach so per Beauftragung, meines Wissens nach und dann händisch. Und daraus resultierend wissen wir dann in etwa wie die Entwicklung auf verschiedenen Achsen oder Regionen.

Johanna Karl Okay, aber die Zählstellen stehen nur an Stellen, wo schon gute Infrastruktur ist.

Interviewte Person Ja, genau. Man muss dazu einfach sagen, das sage ich jetzt ganz deutlich, Radverkehr ist Angebots Planung. Es gibt auch Bedarfsplanung, das ist eh immer klar. Und wenn ich, dann höre, warum fährt da niemand mit dem Fahrrad? Ja, weils dort nichts gibt. Also von daher Radverkehrsangebotsplanung und es gibt natürlich die Zielstellungen der Stadt Wien. Einerseits was den modal split und den shift angeht. Aber auch was die Erreichung der Klimaziele angeht, ist ganz klar dann natürlich auch mit der CO2 Reduktion verbunden und die sind dann eben auch genauso Auftrag für ein Angebotsplanung.

Johanna Karl Okay, verstehe. Also du hast schon öfters die Maßnahmen jetzt angesprochen, was besonders wichtig ist und ich nehme an, das ist politisch gelenkt. Also es geht in die Richtung Klimakrise bewältigen, Anpassungsstrategien. Das heißt, die Maßnahmen, die du als wichtig ansiehst für Fahrradverkehr, nehme ich an, gehen schon in diese Richtung. Mehr Angebot schaffen, Verdichtung.

Interviewte Person Also ja, es gibt natürlich eine politische Entscheidung, da gibt es eine fachliche Grundlage, eine sachliche Empfehlung dazu. Und rein fachlich gesehen. Also ich kann das auch einfach nur rein fachlich beurteilen, dann rein fachlich ist es so, dass Radverkehr, das Netz sollte möglichst durchgängig sein, ohne Lücken. Das bedeutet also eine hohe Qualität, eine hohe, durchgängige Qualität im Verkehrsnetz mit intuitiver Befahrbarkeit. Also es muss einfach so einfach sein wie Autofahren. Die Leute glauben immer das Auto fahren so einfach ist, so einfach ist es nicht. Man muss den Führerschein machen, sich um viele Sachen kümmern. Radfahren ist eigentlich viel einfacher. Aber erst einmal quasi den Umstieg, Menschen müssen sich neu orientieren, haben eine neue Perspektive und das muss einfach möglichst barrierefrei sein. Und dass man einfach da so dahinfährt und sofort weiß, ah okay jetzt rechts abbiegen. Und das natürlich auf einer durchgängigen Qualität und derzeit eben möglichst baulich getrennt.

Johanna Karl Ja, obwohl ja doch noch viel Mehrzweckstreifen ist.

Interviewte Person Ja, natürlich. Man muss einfach sagen auch, weil das eine Frage war, zum Erneuerungsbedarf. Man muss einfach sagen, technische Standards ändern sich, ja. Das ändert sich. Auch die fachliche Sicht auf die Dinge und auch die verkehrskulturelle Sicht. Die hat sich in den frühen 2000ern war es so, dass Mehrzweckstreifen total angesagt waren. Das war die Lösung für alle. Davon zehren wir jetzt noch, im negativen Sinne halt, immer noch. Jetzt sind es halt die baulich getrennten Anlagen, Fahrradstraßen ist natürlich auch eine interessante Sache, gerade wenn man sich jetzt überlegt Flächenverbrauch, Flächeninanspruchnahme. Wir haben ja in Wien das Glück einer kompakten Stadt. Aber natürlich insbesondere im öffentlichen Raum, wird dann auch noch mal alles viel komplizierter, weil wir halt noch nicht diesen Querschnitt haben, wie beispielsweise in Berlin, München hat teilweise auch breitere Straßen, Paris hat deutlich breiter Straßen. Und da muss man sich einfach dann anschauen, wie man damit umgeht. Aber per se muss man mal gucken, welche Maßnahmen passt wo. Und hier ist es halt im deutschsprachigen Raum bei der Verkehrskultur so, dass es im Großen und Ganzen doch die baulich getrennte Anlage braucht, da ist man vielleicht in den Niederlanden einfach weiter, weil einfach mehr Bewusstsein da ist, wie man als VerkehrsteilnehmerIn mit radfahrenden Personen umgeht. Ja da ist einfach dieser

Mindshift in der Vergangenheit eher passiert. Und ich würde sagen, da sind wir noch ein bisschen davon entfernt und deswegen sind es bei uns vor allem die baulich getrennten Anlagen. Wenn es irgendwo passt oder wenn man es in Betracht ziehen kann, dann kann es natürlich auch eine andere Anlageform sein.

Johanna Karl Okay, ja, in Holland ist mir das auch aufgefallen. Auch aufgrund der Literatur. Man liest so viel darüber. Zum Beispiel dieses Copenhagenize Konzept. Ich finde, das Wichtigste ist, dass vor allem die Autofahrer wissen, was sie tun sollen. Das sie wissen, wo sind Radfahrer? Das es klar und deutlich ist. Und hier ist es einfach oft so als Autofahrer kennt man sich nicht aus. Also es kann alles passieren. So, es kann von rechts wer kommen, es kann von links wer kommen. Du hast keinen Platz zu überholen, du bist irgendwie ängstlich. Das fällt mir stark auf. Beziehungsweise auch in Holland zum Beispiel, es ist keine direkte Linienführung, für Autos möglich. Für Radfahrer schon. Und das ist eigentlich einer der Hauptgründe. Ich glaube, dass die Schnelligkeit der Hauptgrund ist, um Rad zu fahren.

Interviewte Person Ja, also es muss nicht immer die Schnelligkeit sein, also die Routenführung ist natürlich schon Thema. In den Niederlanden ist es so, dass die Niederländer eigentlich eher langsam fahren. Das Hollandrad heißt so. Das Tempo ist ein anderes. Ich habe das ganz stark gemerkt. Ich bin ein recht zügiger Radfahrer und sie fahren anders, also sie fahren gleichmäßig. Das Weg Zeit Diagramm ist eigentlich total linear und das ist halt glaube ich das Angenehme, da schwitzt man nicht so viel und so, das ist bei uns anders. Aber auch generell da ist der Verkehr auch sehr langsam. Sie haben jetzt auch die Autobahn auf 100 begrenzt. Davon sind wir hier auch weit entfernt und das ist einfach ein gesellschaftliches Ding. Gleichzeitig aber haben wir schon, da sehe ich jetzt meine Position als Planer, ich bin ausgebildeter Planer, und ich glaube, das schaffen wir in Wien relativ gut. Wenn man sich das anschaut in Kopenhagen beispielsweise, hat jeder seinen Raum. Aber nebenher bleibt nicht mehr viel. Wir haben immer noch die Bauallee, die versuchen wir auch immer in den Planungen unterzubringen. In Kopenhagen ist es dann teilweise recht karg. In den Niederlanden ist es so, das ist ganz interessant, gerade wenn man in der Peripherie ist. Das ist wirklich ein Wahnsinn. Man hat die KFZ Spuren und dann hat man auch oft Nebenfahrbahnen. In Utrecht sieht man das auch, das Nebenfahrbahnen, die Fahrradstraßen sind und dann noch Gehsteige und dann teilweise sogar noch Busspuren. Also unheimlich viel nebeneinander, was wir gar nicht haben. Ja, also Stichwort Flächenverbrauch. Am Land ist es dann noch mal, dass man für eine Spur für Fahrradstraße, dann rechts links Erschließung und dann noch mal die Busspuren. Unfassbar. Der Kollege aus den Niederlanden zum Beispiel, mit dem wir zusammenarbeiten, der auch international unterwegs ist. Der sagt auch immer, wir Holländer, wir können alles gut, auch Autobahnen, und zeigt eindrucksvolle Bilder. Also genau deswegen. Und es ist halt dieses Zusammenspiel an vielen Details bei der Stadt. Hochwertiger ÖPNV, Barrierefreiheit, raus aus dem Asphalt, also Grünflächen, Radverkehr und KFZ Verkehr. Also es mag aus Sicht des Radverkehrs nicht kompromisslos genug erscheinen, nicht progressiv genug. Aber so fürs große Ganze glaube ich, sind wir schon ziemlich gut dabei. Hier und da kann man natürlich mehr für den Radverkehr machen. Das ist eine Perspektiven-Geschichte, aber das kriegt man anderswo nicht so gut unter.

Johanna Karl Und ja, es ist doch auch stark bezirksabhängig. In manchen Bezirken ist es schon gut. Und andere Bezirke, ja, weiter draußen, brauchen länger.

Interviewte Person Manche Bezirke sind auch richtig gut dabei. Donaustadt also legt ein Tempo vor und möchte ich auch betonen da wird aktiv aus der Donaustadt auf uns zugekommen. Können wir da nicht noch was machen? Da ist schon Drang da. Und das unterscheidet sich natürlich. Es gibt die Dezentralisierung, das ist quasi historisch, rechtlich verankert in der Verwaltung, bei uns oder in der politischen Zuständigkeit. Und da haben Bezirke eine gewisse Kompetenz. Das gibt es beispielsweise in Paris nicht. Und auch Paris

beispielsweise ist sehr hierarchisch und sehr zentralistisch. Bei uns ist es eben die Dezentralisierung stärker. In Berlin, da ist es halt super stark. Also das ist der relativ große Unterschied. Deswegen können die Bezirke aber auch mitreden, sollten mitreden. Damit dieser konsensuale Charakter aufrechterhalten wird.

Johanna Karl Okay. Du hast gesagt, Donaustadt. Was sind noch Paradebeispiele, wo es gut ist, wo es gut funktioniert, wo ihr viel vorangebracht habt?

Interviewte Person Ja, Donaustadt ist natürlich ein Schwerpunkt. Wir haben immer so Schwerpunktbezirke. Donaustadt ist natürlich richtig cool. In der Donaustadt entsteht jetzt ein Netz. Viele, bereits asphaltierte Flächen, also meistens Parkplätze kriegen jetzt eine neue Nutzung. Aus meiner Sicht hat das dann einen größeren Sinn, aus meiner Sicht, für den Radverkehr, da kriegen wir auch einige Bäume unter. Und wie gesagt, dieses Netz entsteht, Wagramerstraße.

Johanna Karl Ich kenne die Radwegoffensive.

Interviewte Person Genau und das wird noch viel mehr werden. Da haben wir noch so ein paar Sachen auch noch in den nächsten Jahren. Also es ist wirklich, wie dieses Netz gerade wächst, ist total beeindruckend. Das macht auch richtig Spaß und ich finde, wenn man die Wagramerstraße entlangfährt, kriegt man schon ein Gefühl was es wirklich bedeutet. Ja, gerade diese geradlinige lineare Fahrweise. Man fährt einfach durch, man fährt einfach dahin. Es ist klar, wenn man einfach dem Verkehrsstrom hinterherfahren kann, man kann nebeneinander fahren, das ist es. Argentinierstraße wird auch cool werden. Da bin ich stark involviert gewesen. Das ist ein Projekt, wo ich wirklich dahinterstehe, wo ich wirklich glaube, das es genial wird. Generell der 10. Bezirk wird sehr gut werden. Das sind alles diese Sachen, wo wir auch wirklich in der Fläche die neue Planungsstandards ausrollen. Die RVS ist, glaube ich letztes oder vorletztes Jahr novelliert worden. Daran sind dann auch alle Breiten und so etwas gekoppelt. Also das sind Sachen, wo es dann auch richtig Spaß macht, wenn man sieht, okay, da passiert jetzt was.

Johanna Karl Im 18. ist ja auch bei Pötzleinsdorf, was neues dazugekommen, das richtig cool ist. Ich kannte das vorher, das war wirklich unangenehm. Straßenbahn und so weiter. Und ich frage mich oft, was im 19. Ist und warum es dort so lange braucht. Weil ich bin dort aufgewachsen und ich fahr immer wieder raus. Ich ärgere mich jedes Mal sehr. Es ist jetzt keine Kritik oder irgendwas. Ich glaube es liegt wahrscheinlich am Bezirksvorstand oder ich weiß es nicht, aber da wäre der Platz da so wie im 18.. Da gibt es so viele Stellen. Ja ich fände es schön, wenn es in die Richtung gehen würde, auch dort. Nicht nur in diesen Bezirken wo viel Stadtentwicklung passiert, wo viel Dynamik da ist, sondern auch in vielleicht älteren Bezirken oder die vermeintlich starr sind. Also ich glaube, man kann so viel tun.

Interviewte Person Ja, es ist natürlich schon so, wir versuchen natürlich auch das Gespräch zu suchen und auch immer wieder zu bohren. Mitunter sind es dann auch politische Entscheidungen. Dazu möchte ich nicht sagen, aber ich bin sehr froh, dass die Krottenbachstraße jetzt kommt, wie sie kommt. Und ja, das ist eine richtige politische Entscheidung gewesen, aus meiner Sicht.

Johanna Karl Ja, das sehe ich auch so, okay. Wir haben vorher schon über das Tool gesprochen und ich habe gesagt, dass mehrere Faktoren da einfließen, wie das berechnet wird. Und ich habe da eine Liste, eine Auswahl von Faktoren, die einfließen, in die Berechnung und ich wollte dich fragen, ob du Lust hast, das zu ranken, wie hoch diese Faktoren in Priorität sind für Wien. Also, wie wichtig siehst du es, dass zum Beispiel, wenn Fahrrad Infrastruktur, irgendeine Art von Fahrrad Infrastruktur da ist? Wie hoch ist die Priorität für die Berechnung

des Indexes? Oder bei Steigungen. Wie wichtig ist es, dass es flach ist? Oder dass es eben nicht flach ist? Verstehst du das?

Interviewte Person Schwierig, da bin ich wieder kleinlich, weil Fahrradinfrastruktur ist ja alles.

Johanna Karl Ja, das weiß ich. Aber das ist die Berechnungsgrundlage. Und ich muss, um mein Ergebnis zu haben, diese Gewichtungen ansetzen. Und ich wollte einfach eine kurze Abfrage machen, wie es da so ausschaut. Ein bisschen Gefühl habe ich schon für diese Sachen.

Interviewte Person Und 100 % ist quasi sehr wichtig?

Johanna Karl Ja genau. Also es ist ja so, dass die, werden dann sowieso aufsummiert auf eins, aber einfach eine Art von Bauchgefühl.

Interviewte Person Also es könnten auch mehrere 80 % beispielsweise haben.

Johanna Karl Ja, dann würde ich sie gleich ranken.

Interviewte Person Na ja, Fahrradinfrastruktur ist ja quasi die Frage nach dem Bestand. Also Radinfrastruktur ist ja dann die Bestandsqualität. Es ist einfach mal total wichtig. Man muss es einfach so sagen. Es ist in etwa hier. Steigung ist eigentlich weniger relevant. Steigung ist für die Netzlegung relevant, nicht für die Anlageform. Die Kolleginnen und Kollegen beispielsweise in Tirol sagen natürlich etwas anderes. Wien ist in einer Lage, dass wir darüber nicht nachdenken müssen. Über 6% haben wir nur bei Rampenbauwerken, das ist vernachlässigbar. Aber das natürlich schon, gerade auch in Döbling und 18. Bezirk auch. Möglichst wenig Steigung. Wo liegt das Hauptnetz. Nicht dass man über den Berg fährt, um dann wieder hinunterzufahren.

Johanna Karl Wobei E-Bikes das schon auch wieder mal ein bisschen ausgleichen.

Interviewte Person Ja, aber das ist noch nicht so das Thema, aber ich würde Steigungen mal sagen, liegt so bei 10 %. Ausweisung der Radwege…

Johanna Karl Ob eine Art von Beschilderung gibt.

Interviewte Person Ja, gibts.

Johanna Karl Ja, ich weiß, aber ob sie wichtig ist?

Interviewte Person Das ist schon wichtig. Man sieht es nicht immer draußen, leider. Aber es ist schon wichtig. Die Intuitivität ist ganz wichtig. Wo kann man fahren, auch gerade bei Umleitungen und bei der Orientierung. Anzahl an Kreuzungen. Bedeutet aber dann umso wichtiger, desto weniger Kreuzungen?

Johanna Karl Ja.

Interviewte Person Ja, schwierig zu sagen. Es kommt immer darauf an, wie sie gemacht, also wie ist sie designt. Wie sind die Vorrang Regelungen? Eine kreuzungfreie Fahrt ist im Stadtgebiet schwierig. Es ist natürlich schon eine Qualität. Also man merkt ganz klar, wenn man am Donaukanal entlang fährt.

Johanna Karl Ein anderes Vergnügen.

Interviewte Person Genau es ist halt ein Ideal. Geschwindigkeit der Autos ist ganz wichtig ist eigentlich so wichtig wie die Anlagen.

Johanna Karl Okay, interessant.

Interviewte Person Ja, also Fahrradstraßen mit 50 km/h geht gar nicht. Anzahl der Fahrspuren.

Johanna Karl Das hängt stark mit der Geschwindigkeit zusammen.

Interviewte Person Lärm spielt eine untergeordnete Rolle. Dichte der Bebauung ist schon relevant. Weil ja, potenzielle Nutzerinnen.

Johanna Karl Das stimmt.

Interviewte Person Und es ist schon so, dass wir von schauen, dass wir von innen nach außen bauen.

Johanna Karl Ja.

Interviewte Person Und natürlich sollte der Radweg auch immer eine Erschließungsfunktion haben.

Johanna Karl Dann kommt man erst auf die Idee überhaupt anzufangen.

Interviewte Person Ja, genau das hört man schon auch immer wieder. Die können ja im Park Fahrradfahren. Oder auf der Donauinsel.

Johanna Karl Ja gut, da komm ich nicht in die Arbeit wenn ich auf die Donauinsel fahre. Lärm ist zum Beispiel ein optionaler Datensatz und es geht ja Hand in Hand mit der Geschwindigkeitsbegrenzung.

Interviewte Person Also das ist natürlich schon Teil des Subjektiven Sicherheitsempfindens. Ja, aber in der Stadt wird man dem nicht ganz auskommen. Aber es ist natürlich schon ganz klar. Abstand zur Verkehrsinfrastruktur. Also da, wo es geht, schaut man natürlich, dass man einen Grünstreifen Abstand hat zur Fahrbahn und nicht unmittelbar an der Fahrbahn entlangfährt. Es gibt die Schutzstreifen nach RVS, dass man den Abstand hat 50 Zentimeter neben der Fahrbahn. Das machen wir in Wien eh immer mit 60. Weil die Verkehrsschilder so aufgestellt werden müssen, dass sie genug Abstand zur Fahrbahn haben als auch zum Radweg. Aber mitunter ist es trotzdem unangenehm, am Gürtel oder beispielsweise dann da zu fahren.

Johanna Karl Ja, ich bin auch schon lange am Rad in Wien unterwegs. Ich glaube ich verstehe diesen Aspekt. Gut, abschließend zu dem Tool würde mich interessieren, gibt es Potenzial für den Planungsprozess? Dass man das als zusätzliche Datengrundlage nimmt, zusätzlich zu den einzelnen Zählstellen, man kann das ja auch noch ausbauen, die Berechnungsmethode anpassen etc.

Interviewte Person Aus meiner Sicht, ja definitiv. Die Frage ist immer, wie einfach ist es zu befüllen? Wie einfach ist es quasi, auch zu verwalten? Kann man dieses Tool möglicherweise automatisiert befüllen? Es gibt etwas ähnliches wie Google Street View, was in Magistratsabteilung verwendet wird, wo quasi Bilder aus dem Straßenraum, wo man das händisch macht. Eine automatisierte Messung gibt es derzeit, meines Wissens nach nicht. Also es sollte nicht mehr Arbeit in der Verwaltung machen. Bedeutet also eben, es ist einfach zu handeln und der Informationsfluss ist da. Dann ist es natürlich schon interessant. Drei Häkchen gemacht und man sieht okay, Hauptradverkehrsnetz, hier und da haben wir diese und diese Breiten. Dann weiß man sofort das ist alles RVS konform. Das nicht. Im Großen und Ganzen wissen wir es eh, weil wir natürlich täglich im Netz unterwegs sind, gedanklich als auch praktisch. Aber rein für die objektive Betrachtung und so, dass man einfach mal alles auf einem Bild dargestellt hat, dafür wäre es natürlich schon praktisch, ja.

Johanna Karl Und auch vielleicht plakativ. Wenn man sich repräsentieren möchte oder auch Dinge ausprobieren möchte. Wie wirkt sich diese Veränderung aus?

Interviewte Person Ja, also ich glaube das Plakative braucht es manchmal in Besprechungen. Innerhalb der Stadt Wien gibt es ein heterogenes Feld der Positionen. Das heißt auch Aushandlungsprozesse finden, auch fachlich intern statt. Und auch dafür wäre es natürlich spannend. Das Ausprobieren weiß ich jetzt gar nicht unbedingt, da ist man dann schon eher auf der Detailebene.

Johanna Karl Das ist technisch eh noch nicht möglich.

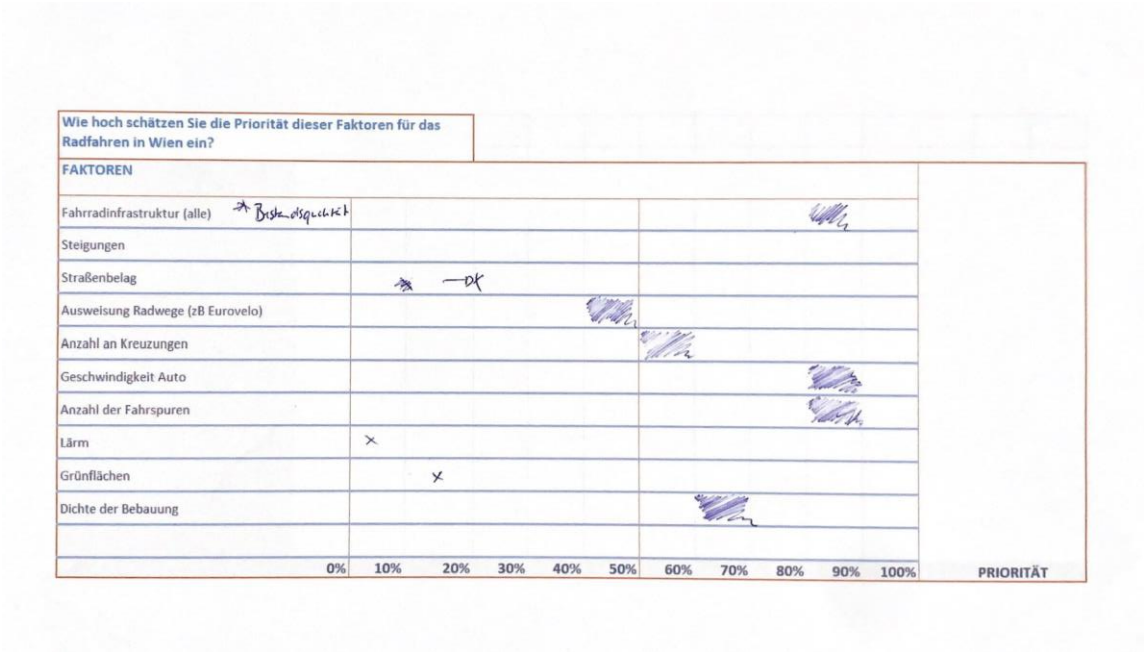
Interviewte Person Also man kann auch sagen, die Leute, die hier eigentlich damit arbeiten, die schauen auch in der Freizeit, dann wird mal ein extra Schlenker gefahren und dann wird das ausprobiert.

Johanna Karl Ja, das ist halt auch eine Passion, nehme ich an.

Interviewte Person Schon, ja. Also die meisten Kolleginnen und Kollegen stehen passioniert dahinter.

Johanna Karl Ja, sehr interessant. Gut, ich glaube, ich habe ein Bild bekommen. Danke.

Interview 1: Handout



11.3 Interview 2: 20.06.2023: Survey, Transcript, Handout

Interview 2: Survey

Wien, 20.06.2023

Interviewerin: Johanna Karl, Studentin Masterstudium Kartographie und Geoinformation

Interviewter: anonymous

Dauer: 30 min.

Thema: Messung der Bikeability (Fahrradfreundlichkeit/Tauglichkeit) der Stadt Wien mittels der NetAScore Toolbox im Rahmen einer Masterarbeit

Ablauf:

5. **Vorstellung (Recording, Anonymität?)**
6. **Intro Masterarbeitsthema**
7. **Ziele der Interviews**
8. **Fragen**
    - Für welche Bereiche der Radverkehrsplanung sind Sie in der MA18 zuständig?
    - Welche der Ziele, die im Fachkonzept Mobilität des STEP2025 in Bezug auf den Modal Split festgelegt wurden, können erreicht werden? Was kommt danach?
    - Welche Datengrundlagen haben Sie, um den Radverkehr zu messen und dem Bedarf an Radwegen an den richtigen Orten gerecht zu werden?
    - In welchen Teilen Wiens funktioniert Ihrer Meinung nach das Radwegenetz gut?
    - Welche Probleme sehen Sie in der Umsetzung oder Planung der Radwegeinfrastruktur in Wien?
    - Worauf liegt der Fokus in den nächsten Jahren?
    - Wie wichtig schätzen Sie die folgenden Faktoren für den Radverkehr in Wien ein? Bewerten Sie deren Relevanz indem Sie es einzeichnen (siehe unten).

Interview 2: Transcript

Johanna Karl Ich habe ja schon ein paar Fragen im Vorhinein geschickt. Mein Ziel ist es, unterschiedliche Stellen der Stadt zu verstehen und zu wissen, wie das zusammenhängt, damit ich das in meiner Arbeit auch fundiert schreiben kann. Wie der aktuelle Stand ist, was verwendet wird und damit ich das gesamtheitlich abbilden kann. Ich möchte auch einfach die lokalen Gegebenheiten verstehen können, durch Expertenmeinungen, aber von Problemen erfahren, die es gibt in der Stadt, damit man das verstehen kann, auch als Leser. Damit man das Gespräch gut einleitet, würde ich Sie bitten zu sagen für was Sie, oder die MA18 genau zuständig sind und welche Bereiche der Radverkehrsplanung abgedeckt werden.

Interviewte Person Im Referat Mobilität wird alles abgedeckt von der U Bahn Planung, über die Fußwege bis hin zum Parkraum, Radfahren, Straßenbahn. Also wirklich sehr viel. Auch natürlich die Konzepte, die Fachkonzepte. Das ist dieser große ideologische Überbau und ich bin eben für den Radverkehr zuständig. Wir sind eigentlich sozusagen in einer Planungsstufe natürlich eine Stufe höher als die Umsetzung des Projekts. Wir sind konzeptionell zuständig. Wo ist das Hauptradwegenetz? Wo ist es jetzt, wo nicht, wo sind die großen Achsen, das sind unsere Themen? Und dann natürlich auch die Frage, Wie kommt man jetzt von dem Idealbild Achse hin zu so einem Projekt, das auch eine gewisse Umsetzungswahrscheinlichkeit hat. Wir sind dann beim Umsetzungsprozess auch natürlich noch als Fachexperten dabei. Also bei den Detailplanung der MA28, die dann sozusagen den Straßenbau dann auch übernimmt und der die entsprechenden Planungen machen muss für die Umsetzung. Also wir bereiten vor, wir haben die Vision, wir versuchen das auf den Boden zu bringen, aber natürlich auch zu einem gewissen Maßstab von der Politik. Wenn das grundsätzlich auch von der Politik abgesegnet ist dann wird es im Detail abgehandelt.

Johanna Karl Wie seid ihr in Zusammenarbeit mit der Mobilitätsagentur?

Interviewte Person Ja die Mobilitätsagentur sind bei uns im konzeptionellen Bereich immer dabei, die MA28, die MA46, die MA42 wenn es um Grünflächen geht, das eine oder andere Mal auch die MA33, wenn es um Ampeln und Beleuchtung geht. Also wir stimmen uns mit den Stellen ab, sehr intensiv. Und es gibt ja auch das Kernthema Radverkehr bei uns das ist einmal im Monat, wo alle zusammenkommen und dann die aktuellen Themen besprechen. Ja, und da bin ich auch dabei.

Johanna Karl Danke. Ja, es gibt ja den Stadtentwicklungsplan 2025, aber es gibt ja jetzt mittlerweile schon den neuen, den 2035. Also er ist noch nicht da, aber er wurde angekündigt. Ich kenne die ungefähren Ziele, die da drinnen festgelegt wurden. Das sind wahrscheinlich einfach Richtlinien, nehme ich an? Also das Ganze ist ja eher eine strategische Ausrichtung, sagen wir so, oder? Und ja, kann man schon abschätzen, was davon wirklich realisiert wurde? Zum Beispiel das Ziel, dass 80 % des Mobilitätsverhalten von öffentlichem Verkehr, Radverkehr, Fußverkehr eingenommen werden soll, mit 2025? Ist das realistisch?

Interviewte Person Wahrscheinlich nicht. Nach den derzeitigen Zahlen, Mobilitätserhebung wird jedes Jahr durchgeführt. Und die hat noch immer 25- 27 % ÖV, je nachdem wie man es rechnet. Durch die Pandemie hat sich das Radfahren doch ein bisschen erhöht. Früher waren wir bei 7 %, jetzt sind wir bei 9 %. Aber es gibt eben dieses 80 % Umweltverbund Ziel. Da ist es jetzt egal ob der ÖV was beiträgt oder der Radverkehr. Es wird sich nicht ausgehen, sage ich jetzt mal, aber trotzdem muss man sagen die Richtung passt ganz gut. Aber es ist natürlich so, wenn man das wirklich erreichen will, muss man vielleicht noch mehr machen. Es ist jetzt die Parkraumbewirtschaftung auf ganz Wien ausgelegt worden. Vielleicht muss man da noch nachschärfen, bei den großen Bezirken. Das ganze Thema ist eine politische Frage natürlich auch. Wir versuchen beim Radfahren und das ist schon sehr auffällig jetzt die letzten Jahre, die Offensive Radfahren. Die letzten zwei Jahre mit dem vierfachen Budget und mit den rund 50 Projekten im Jahr. Das ist jetzt schon ein Kraftakt für die Dienstellen, das muss ich sagen, das ist natürlich schon eine Vervierfachung des Aufwands. Und man sieht auch draußen, dass da schon Qualitäten gebaut werden und dass da Ziele dahinter stecken, große Achsen wie die Nordachse (Praterstraße- Lassallestraße- Wagramerstraße), da wird jetzt sukzessive auf dem ganzen Band gearbeitet. Also es gibt schon im Radverkehr eine sehr große Dynamik derzeit. Wie weit sich das dann weiter in Modal Split Zahlen zeigt, wird sich zeigen. Also ich gehe davon aus, dass mehr Leute fahren werden, weil man muss ja rechnen, die Bevölkerung steigt auch. Das heißt mehr Leute am Rad. Heißt ja nicht, dass mehr Modal Split ist. Sondern, im Verhältnis bleibt es vielleicht gleich, in den absolut Zahlen steigt es natürlich mit steigender Bevölkerung. Dass es im Verhältnis steigt, das ist das Ziel. Ob es gelingt, das kann man schwer abschätzen. Jede einzeln Bewegung in der Stadt ist ja immer eine persönliche Entscheidung. Man kann ja nur mit sozusagen Angebot, aber natürlich auch in gewisser Weise mit Faktoren negativer Art agieren. Also sprich, ich muss zahlen, wenn ich mit dem Auto in die Stadt fahren will, zum Beispiel. Das ist sozusagen eine negative Maßnahme. Es gibt die offensive Maßnahme, wenn ich den Radweg baue und hoffe da fährt einer. Das ist jetzt die Frage, wie weit das bei der Bevölkerung ankommt.

Johanna Karl Also es ist schon viel Angebotsplanung, wahrscheinlich.

Interviewte Person Am Radverkehr auf jeden Fall, Angebotsplanung. Aber natürlich muss man sagen, haben wir mittlerweile Gott sei Dank so viele Radfahrer in Wien, das es auch auffällig, ist, dass gewisse Stellen nicht passen. Zum Beispiel bei der Urania oder auf der Praterstraße da sieht man schon, es ist Handlungsbedarf. So gesehen kommt das Angebot einerseits aus dieser Planungs-Philosophie heraus und ist jetzt natürlich aus den Gegebenheiten draußen gebaut worden. Der Radweg, der vor 20 Jahren gebaut wurde, der passt heute nicht mehr, man muss was machen. Lückenschluss ist das eine Thema,

Bestandsverbesserung das andere. Also das ist sozusagen die Strategie, beides. Und möglichst durchgängig mit Qualität.

Johanna Karl Im 2035er Stadtentwicklungsplan sind da die Ziele anders ausgerichtet, was den Radverkehr angeht oder geht es weiter?

Interviewte Person Das kann keiner sagen. Jetzt ist es in Ausarbeitung. Es wird wahrscheinlich nächstes Jahr beschlossen werden. Und so lange es nicht beschlossen ist, macht es keinen Sinn darüber zu diskutieren, weil es ist auch ein politischer Abstimmungsprozess. Also es gibt eine Fachexpertise, dann gibt es eine politische Abstimmung und dann gibt es letztendlich einen Beschluss.

Johanna Karl Okay, also Sie haben gesagt, dass eben, wenn man merkt, es gibt Problemstellen. Sehen Sie das über die Verkehrskameras oder welche andere, oder merken Sie das selber wenn Sie Rad fahren? Oder wie merken Sie, wo Problemstellen dezidiert sind? Oder kriegen Sie Meldungen rein? Oder wie funktioniert das mit der Datengrundlage bis jetzt?

Interviewte Person Also die Mobilitätsagentur macht ja das Management sozusagen zum Bürger. Es gibt ja auch die Wien App. Da kriegt man dann schon ein Stimmungsbild. Dann gibt es natürlich auch Briefe, die an die Politik oder Bezirkspolitik oder ins Rathaus direkt geschickt werden. Natürlich ist es auch klar, dass wir als Experten viel sehen und draußen dieses Weiterentwickeln des Systems aktiv vorantreiben. Und da ist die Frage auch, was uns betrifft, wo stecken die Prioritäten drin? Ja, also wie wichtig ist jetzt diese eine Stelle, die nicht funktioniert? Also zum Beispiel der Ring Radweg, der jetzt auch schon an die Leistungsgrenze stößt. Also der hat sicher eine andere Bedeutung im Gesamtsystem als irgendein Radweg in Floridsdorf der zu schmal ist. Also da geht es auch um diese Bewertung. Und das passiert auch in diesem Arbeitskreis in diesen Abstimmungsprozessen. Das man auch bei der Erstellung der Bau-Programme schaut, wo sind Projekte, die das Gesamtsystem wirklich voranbringen und wo ist es nice to have, weil dort vielleicht gerade aufgegraben wird. Natürlich gibt es auch die Radverkehrszählstellen, wo man auch sieht, wie hoch diese wirklich mittlerweile sind. Letztes Jahr hatten wir einen Tag im Sommer mit 10.000 Radfahrern. Also da sieht man sozusagen schon, welche Belastung ist auf diesen Abschnitten. Und natürlich muss ich dann irgendwann einmal sagen, die Fläche reicht nicht mehr aus, oder diese Frage der Ampeln oder der Engstellen und so. Aber es gibt kein Bestands-Management.

Johanna Karl Keine systematische Erfassung. Okay.

Interviewte Person Was ich als Fehler finde. Die Mobilitätsagentur wäre ja sozusagen diese Stelle wo ein Kommunikationsmanagement stattfindet etc. Vielleicht braucht es etwas wie die Mobilitätsagentur. Dass sich eine Gruppe wirklich beschäftigt und sagt, wie schauts da draußen aus? Es geht ja nicht immer nur um die großen Sachen, sondern auch um Verkehrszeichen, Bodenmarkierungen etc. Also wenn etwas großes gebaut wird wie der Lassallestraßen Radweg geht es ja trotzdem noch um Details auch. Ich glaube das ist auch wichtig im Gesamtsystem. Aber wenn jemand jeden Tag an der selben Stelle vorbei fährt und sich denkt, das ist aber blöd. Dann macht das auch etwas aus.

Johanna Karl Aber ich glaube, die Radlobby hat ja zum Beispiel auch schon relativ viel Informationen und Daten schon gesammelt von Nutzern. Also es gibt einiges.

Interviewte Person Also die Mobilitätsagentur nimmt das ja auch auf, was hineinkommt. Das spielt dann auch in die Umsetzungsdienstellen hinein. All diese Punkte werden natürlich in die Verwaltung gespielt, aber die Verwaltung kann es auch nicht selber reparieren, sondern die braucht Geld dafür. Je nachdem ob es im Bezirksbudget ist, oder ein zentrales Budget. Da muss also ein gewisses Verfahren abgewickelt werden. Dementsprechend ist es natürlich so,

dass es lange dauert, bis irgendwo was dann passiert. Weil das Geld nicht da ist, oder das Verfahren dauert. Wenn zum Beispiel der Bezirk sagt, das ist nicht mein Hauptproblem.

Johanna Karl Wahrscheinlich oft zum Beispiel im 19.? Ich merke, dass wenn ich raus fahre, dass ich mich über vieles ärgere. Aber anderes Thema.

Interviewte Person Da haben wir ja jetzt einen wunderschönen neuen Radweg.

Johanna Karl In der Krottenbachstraße, ja. Das heißt Probleme in der Umsetzung, politisch? Oder wo sehen sie noch Probleme?

Interviewte Person Jetzt haben wir ein vierfaches Budget, aber das ist auch endend. Ein hoch priorisiertes Projekt kann auch oft politisch sehr schwierig sein. Also sie sehen diese Prozesse dauern. Und da ist unsere Position dann immer wieder nachzufragen. Aber es dauert. Also die Abteilungen brauchen natürlich auch die Personalressourcen dazu. Mittlerweile ist auch das nicht mehr die Planungsressource ein Thema, sondern auch die Bauressource. Wenn jetzt eine vierfache Bauleistung ist, heißt es auch für diese Gruppe, die sich mit dem Bau beschäftigt, dass sie eben auch Personal brauchen. Also es gibt da schon auch Hemmnisse oder Schwierigkeiten, wenn die Kapazitäten nicht wirklich vorhanden sind. Also wenn jetzt noch einmal eine Verdoppelung des Budgets wäre, das wäre mit der Mannschaft nicht mehr zu schaffen. Das ist jetzt gerade brisant.

Johanna Karl Dass wird ja weitergehen nächstes Jahr.

Interviewte Person Das ist auch ein Thema, 2025 ist die nächste Wahl. Wir haben ja gesehen, was bei Wahlen alles passieren kann, wir werden sehen, wie das jetzt weiter ausgeht. Es ist zu hoffen, dass es weitergeht. Aber es gibt keine Garantie. In Niederösterreich ist jetzt ein blauer Landesrat zuständig für die Agenden. Es ist jetzt kein Geheimnis, dass die FPÖ nicht die ganz große radfahr-freundliche Partei ist. Also so gesehen, wird man sehen, wie sich das auswirkt. In Wien ist das zwar unwahrscheinlich aber es kann theoretisch sein.

Johanna Karl Aber der Stadtentwicklungsplan, der gibt doch auch eine Leitlinie vor. Abgesehen von politischen Stimmungen.

Interviewte Person Ja, aber ich sage jetzt einmal den kann man auch anders interpretieren. Also die Politik hat die Mittel, das Budget zu steuern. Das ist ja gut. Aber es kann natürlich auch dann wieder in eine andere Richtung gesteuert werden, aber dafür gibt es keine Garantie.

Johanna Karl Okay, dann komme ich noch zu dem letzten Punkt. Da bitte ich Sie, wenn Sie Lust haben das auszufüllen. Ich habe vorhin schon erzählt, dass verschiedene Faktoren in diesen Index hinein berechnet werden. Wie hoch Sie die Priorität der einzelnen Faktoren einschätzen? Haben Sie Lust das kurz zu machen? Sie können es mir auch mündlich mitteilen.

Interviewte Person Die Radinfrastruktur ist immer nachgefragt. Sie haben vielleicht auch bemerkt, dass wir jetzt bei der Radinfrastruktur einen wirklichen switch haben, dass man wirklich versucht, die Radwege jetzt zu forcieren. Also dieser Boom der Mehrzweckstreifen in den 2000er Jahren, der hat sich herausgestellt, war doch nicht der Weisheit letzter Schluss. Viele Leute sind unglücklich damit. Der Profi-Radfahrer oder der versierte Radfahrer kann fahren dort, aber nicht so geübte oder schwächere Verkehrsteilnehmer nicht. Das heißt, die Radfahrinfrastruktur ist wichtiger Punkte, da geht es vor allem um die Verlässlichkeit und dieses Durchgängige. Dass ich eben nicht hinter einem langsamen Radfahrer hinterherfahren muss, sondern dass ich eine Breite habe, wo ich vorbei fahren kann. Die Steigungen sind in Wien natürlich ein Thema, aber hat sich ein bisschen aus meiner Sicht mit dem, E-Bike Boom reduziert. Aber natürlich, zum Beispiel Berggasse, der zwar direkt ist, aber man muss aus dem Sattel raus. Ich fahr ihn trotzdem. Aber in den westlichen Randbezirken ist das natürlich schon

ein Thema. Jenseits der Donau, nicht. Also im Großen und Ganzen, ist das sehr Bezirksbezogen.

Johanna Karl Aber über gesamt Wien gerechnet wahrscheinlich eher nicht.

Interviewte Person Nicht ganz so, nein. Die Ausweisung der Radwege. Also die Beschilderung. Die ist nicht mehr so ein Thema, weil es Navigations Apps gibt. Man kann sich das auf den Lenker geben, wenn man eine Navigation braucht. Also die großen Radwege sind beschildert, aber ich sehe, es jetzt ehrlich gesagt nicht so wichtig. Die Kreuzung sind ein endlos Thema, das ist 100% wichtig. Da sage ich jetzt mal, da geht es halt auch um den Autoverkehr. Am Gürtel ist es auf 50 ausgerichtet, die grünen Phasen und der Radfahrer steht dann oft. Den Verkehrsfluss, den sehe ich schon sehr wichtig. Ja, Geschwindigkeit Auto ist, insbesondere wenn auf der Fahrbahn die Radfahrer sind, das zweitwichtigste Kriterium. Was hier fehlt vielleicht noch wäre die Schiene.

Johanna Karl Ja.

Interviewte Person Das gibt es gar nicht. Die Schiene ist ganz unbeliebt. Also dieses Geschwindigkeit Auto ist sicher ein ganz wesentliches Thema und zusätzlich kommt da bei uns noch dazu die Schiene und deshalb gibt es auch in den Schienen Straßen relativ wenig Radverkehr. Außer es ist eine verkehrsberuhigte Schienen Straße, wo ich in der Mitte der Gleise fahren kann. Wenn ich von hinten nicht den Druck habe von den Autos. Die Anzahl der Fahrspuren ist ganz wesentlich. Also, wie gesagt, am Ring zum Beispiel, da gibt es drei Fahrspuren also man müsste da, wenn man weg möchte von diesen engen Wegen in den Alleen, eine Fahrspur weniger oder die Nebenfahrbahnen komplett für Radverkehr öffnen. Das wäre aus meiner Sicht das Beste. Lärm, natürlich fahre ich lieber in einer verkehrsberuhigten Zone. Aber am Gürtel, wenn ich schnell vorankomme, dann stört es mich auch nicht. Grünflächen, ja im Idealfall ist es so, dass eine Fahrbahn ist, dann eine Baumreihe dann der Radweg. Das ist psychisch auch ein anderes Fahrgefühl.

Interviewte Person Und Dichte der Bebauung ist ja eigentlich was Gutes. Also wenn, dichtere Bebauung ist, ist auch mehr Radverkehr. Irgendwann ist es dann zu viel, wobei wenn man alleine ist auf einer Fahrbahn ist es auch nicht gut. Weil der Autofahrer mich gar nicht wahrnimmt. Also das wäre so eine grobe Beurteilung.

Johanna Karl Den Straßenbelag haben wir ausgelassen.

Interviewte Person Man redet viel über die Versiegelung. Da gibt es eine Diskrepanz zwischen der Entsiegelung von Wegen, und gleichzeitig ist aber dann der Rollwiderstand sehr viel höher und die Belagsqualität, ist sehr viel schlechter. Die Umweltschutzabteilung fragt dann nach, warum muss man dort versiegeln, der Weg war aber quasi nicht befahrbar. Das heißt, wir würden schon die Asphaltierung, und die Belagsqualität garantiert empfehlen.

Johanna Karl Ja, okay danke.

Interview 2: Handout

The handout was given to the interviewed person and he/she verbally explained his/her estimations.

11.4 Interview 3: 28.06.2023: Survey, Transcript, Handout

Interview 3: Radlobby Wien, Survey

Interviewerin: Johanna Karl, Studentin Masterstudium Kartographie und Geoinformation

Interviewter: Roland Romano, Radlobby Wien, Themen: Sprecher, Infrastruktur, Verkehrspolitik
Dauer: 15 min.
Thema: Messung der Bikeability (Fahrradfreundlichkeit/Tauglichkeit) der Stadt Wien mittels der NetAScore Toolbox im Rahmen einer Masterarbeit
Ablauf:
1.Vorstellung (Recording, Anonymität?)
2.Intro Masterarbeitsthema
3.Ziele
4.Fragen

- Welche Aufgaben hat die Radlobby Wien?
- Welche Maßnahmen sehen Sie in Zukunft als besonders wichtig für den Fahrradverkehr in Wien an?
- Welche (strategischen) Probleme sehen Sie in der Umsetzung oder Planung von Radwegeinfrastruktur in Wien?
- In welchen Teilen Wiens funktioniert ihrer Meinung nach das Radwegenetzwerk gut? Welche müssen verbessert werden?
- Was braucht es damit Meldungen und Problemstellen noch direkter an die Stadt herangetragen werden?
- Wie wurde die Radlkarte entwickelt?
- Radkummerkasten. Wie funktioniert die Kommunikation mit der Stadt?
- Wie wichtig schätzen Sie die folgenden Faktoren für den Radverkehr in Wien ein? Bewerten Sie deren Relevanz, indem Sie es einzeichnen (siehe unten).

Interview 3: Transkript

Johanna Karl Also, zum Einleiten. Was sind die Aufgaben der Radlobby? Was siehst du als wichtigste Handlungsfelder von der Radlobby Wien in dem Fall.

Radlobby Also wird eine Interessensvertretung, tun das aber, glaube ich auf eine innovative und sehr effiziente Art und Weise. Wir sind ein sehr kleines Team hier im Büro, gemeinnützig und überparteilich und wir arbeiten für Bewusstsein, für neue Regelwerke, also sozusagen die Software, (StVo, Bauordnung, Fahrradverordnung) und auch an der Hardware, dass quasi bessere Infrastruktur auf den Boden kommt und da vor allem die großen Sachen. Hauptradrouten, wenn die auf Hauptstraßen stattfinden, dass man dort getrennte Wege anlegt, Stichwort Radwege auf Hauptstraßen und wenn die im untergeordneten Straßennetz verlaufen, dann Fahrradstraßen. Und neben diesem Hauptthema des Radnetzes gibt es noch die kleinen Sachen wie Rad-Bügel, die quasi über die ganze Stadt verstreut sind und das Thema Einbahn Öffnungen sowie Verkehrsberuhigung – Stichwort Superblocks. Genau das versuchen wir zu erwirken. Vor allem auf Wien Ebene. Dann gibt auch noch Bundesthemen auf Österreich Ebene, wo wir mit dem Bundesministerium zum Beispiel oder Richtung Parlamentsparteien oder Bundesländer Netzwerk arbeiten. Aber in Wien geht es vor allem um die Wiener Verordnungen, Regelwerke und die Infrastruktur. Und parallel zu dem, Bewusstseinsbildung bei der Politik, Verwaltung, aber auch der Bevölkerung. Das ist hier für die Abstand Kampagne passiert. Bewusstseinsbildung im weitesten Sinne. Dass sind die Themen, die wir meinen, die wichtig sind, um mit dem Bestand auszukommen. Und mit dem Magazin Drahtesel (der kommt vier mal im Jahr heraus). Das einzige Magazin im deutschsprachigen Raum neben dem ADFC Magazin, das in deutscher Sprache Radverkehr in umfasst. Also wir haben auch eine Watchdog Funktion in gewisser Weise. Und da gab es schon genug Gelegenheiten, wo das auch notwendig war, dass jemand darauf schaut. Also außerhalb der Radlobby gibt es für erstaunlich wenige, vielleicht noch den VCÖ. Aber wenn jetzt quasi Radwege rückgebaut würden oder Radwege verschwinden oder Eisenbahnen wieder verschlossen werden, die eigentlich offen waren, dann gibt es viele Betroffene, die sich

aber nicht bei dem Anlass jeweils formieren. Also wir sind dann die, die sagen so geht es nicht und es muss wieder her.

Johanna Karl Okay, danke. Gibt konkrete Maßnahmen, die du oder ihr als wichtig anseht in Wien in Zukunft? Was ist euer Fokus? Ich sehe Abstand, 30er Zone. Was gibt es noch?

Radlobby Das ist natürlich eine schöne Arbeit, weil man Bewusstsein schaffen kann. Aber man schafft kaum Veränderung, da muss man ehrlich sein. Also das wird die nächsten 10- 20 Jahre gehen, dass man Abstandsarbeit machen muss, so lange, bis eine neue Generation das neue Gesetz in der Fahrschule gelernt hat. So langsam sind die Entwicklungszyklen.

Johanna Karl Ich habe es noch nicht gelernt.

Radlobby Okay, konkrete Ziele, zum Beispiel, dass die Bauordnung novelliert wird. Da gibt es bisher quasi keine Qualitätskriterien, zum Beispiel für Rad-Bügel.

Johanna Karl Ist das die Straßenverkehrsordnung?

Radlobby Die Wiener Bauordnung, wie Gebäude auszustatten sind? Da gab es keine Qualitätskriterien, was Radabstellanlagen betrifft. Das ist dramatisch was da passiert. Es soll jetzt die Bauordnung in Begutachtung gehen in den nächsten zwei Wochen glaube ich. Für Wien, also was wir jedenfalls anstreben, ist ein zeitgemäßes Radverkehrs-Budget. Wien hatte, 10 Jahre lang oder noch länger, nur 6 Millionen € im Jahr. Das konnten wir mit „Platz für Wien“ und unseren Gesprächen auf jetzt 20 Millionen anheben, immerhin einer Erhöhung. Aber wir sind noch lange unter dem, was es eigentlich braucht. Es gab eine bundesweite Studie von allen Bundesländern, wo auf 300 Seiten ermittelt wurde, wie viel Geld man braucht, um den Radverkehr Österreich zu verdoppeln. Da kommt heraus für Wien ungefähr 800 Millionen €. Wenn wir jetzt 20 investieren dann dauert es drei Jahrzehnte, um mal das Netz zu haben, dann haben wir noch nicht nie Radverkehrssteigerung.

Johanna Karl Das ist einmal das Angebot.

Radlobby Ja, genau. Also in den Straßenbau wird das vielfach investiert, mit den Brücken Sanierungs-Projekten das x fache. Da haben wir noch gar keine Zahlen. Und im öffentlichen Verkehr, das Zehnfache mehr als das Zehnfache. Pro Person. Zum Vergleich. Obwohl vom Modal Split her der Unterschied bei 3-5 liegt. Also da müsste man noch mal um den Faktor drei hoch. Wir haben auf Basis der Zahlen gesagt aus der Studie, wenn man das runterbricht, auf die Wiener Bevölkerung und bis 2030. Dann kommen 50 € pro Einwohner heraus und das wäre dann etwa das Vierfache vom jetzigen.

Johanna Karl 50 €, auf die Zeit gerechnet jedes Jahr.

Radlobby Wir hatten bisher eine österreichweit einheitliche Forderung von 30 €, aber noch keine Studie, wir haben das geschätzt. Ja, in Wien sind es 50 geworden und in NÖ 100, durch die Kilometer zwischen den Ortschaften. Genau, das ist das Budget und damit einhergehend auch das Personal.

Johanna Karl Ja, die Steigerung des Budgets alleine ist noch nicht die Lösung, sondern sie brauchen auch Personalressourcen.

Radlobby Ein Teil davon, also das Budget, ist halt immer Ressource. Zu den 8 Millionen gehört auch die Planung von den Projekten. Das ist das Große. Und davon wollen wir eigentlich quasi das Netz. Und da hat halt Wien jetzt kein Netz, sondern eher einen Flickenteppich. Da gab es eine große Studie von Grow Bike. Die haben das Radverkehrsnetz analysiert. Die Strategie, zufällig zu investieren ist nicht zielführend. Wenn man dann lauter Punkte hat auf der Karte hat statt ein Netz. Und deswegen müsste man eigentlich schauen,

wo sind die größten Komponenten und wo schafft man eine Verknüpfung, dass man vielleicht kein enges Netz schafft, aber zumindest einmal Wienweit auf einem Netz durch die Stadt kommt.

Johanna Karl Wobei die Stadt sagt schon sie bemühen sich um durchgängige Qualität, oder zumindest zusammenhängenden Bestand.

Radlobby Ich spreche niemandem das Bemühen ab. Wenn man den Datensatz analysiert, kommt man darauf dass das Netz nicht durchgängig ist.

Johanna Karl Oder wenn man einfach Fahrrad fährt.

Radlobby Ja, das wissen wir alle, wenn man das objektivieren möchte, dann kann man das alles relativ gut im Datensatz ablesen. Na gut, das waren die Oberziele. Uns geht es um die Kilometer und dass man diese Angststellen schließt. Das man die identifiziert und quasi die Lücken zwischen den Bestandteilen, Stichwort Getreidemarkt, schließt. Wenn die Route nicht auf der Hauptstraße liegt, dann braucht man nicht unbedingt einen Radweg. Dann kann man mit Verkehrsfiltern und Fahrradstraßen arbeiten. Und abseits von den Hauptstraßen meinen wir, dass flächendeckend Superblocks gut wären. Nicht nur Anrainern, das ist wichtig zu unterscheiden. Es sollte jeder zu jedem Haus zu fahren können. Also Beschränkung auf eine Zu und Abfahrt, aber offen für jeden. Genau, dann fehlen noch 30.000 Stellplätze bis 2025. Und dann gibt es noch das Thema Einbahn Öffnungen. Also bisher sind nur 48 % aller Kilometer geöffnet. Und wir wollen auf 90 % kommen und damit haben auch die Parteien geworben. Wir haben es geschafft das sowohl NEOS, Grüne, aber auch die SPÖ unsere Forderungen übernommen haben oder gewisse Aussagen versprochen haben. Das ist wichtig, das war die Willensbekundung. Jetzt kann man sie beim Wort nehmen. Insofern war das wichtig, sonst wären viele Sachen jetzt auch nicht gekommen. Also so große öffentliche Beschlüsse oder Bekanntgaben, Outings von Parteien gab es seit langem nicht zuletzt bei Kreisky. Auch auf Bundesebene, wurde es (Anm.: Das Budget für Radverkehr) von 8 auf 60 Mio. angehoben. Aber eigentlich braucht es noch deutlich mehr. Auf Länderebene genauso. Also wir machen Fortschritte. Es ist sicherlich seit 2020 so viel passiert wie noch nie in unserer Karriere oder zumindest in meiner Laufbahn. Aber das ist noch weit weg von erfüllt. Weil wir bisher auf so niedrigen Niveau waren ist eine Verfünffachung super für sich. Das muss man realistisch sehen.

Johanna Karl Du hast eh schon viele Probleme angesprochen. Das heißt es mangelt oft am Geld, an Ressourcen, auch am Personal.

Radlobby Das Geld ist da, aber nicht für den Radverkehr. Bei der U5 sind wir bei 6 Milliarden statt 1. Man könnte mit diesen Geldern mehr erreichen. Zig Radverkehrsnetze in Wien bauen. Also das sind Dimensionen, das kann man sich gar nicht vorstellen. Aber in der Dimension ist das schon eine eindeutige Schieflage. Dass man hier extrem investiert, Priorisierung und den NMIV verräumt.

Johanna Karl Also ihr wisst ganz genau, an welcher Stelle kommt es zu welchem Problem? Wie funktioniert die Kommunikation? Ihr habt alle Informationen. Gibt ihr sie weiter oder gleich direkt an die Magistrate? Treffen Sie sich regelmäßig? Wie ist der Austausch?

Radlobby Also bisher, bis 2022, vor allem über den Rad-Kummerkasten. Und über die Bezirksgruppen. Da haben wir all die kleinen Anliegen (Markierung fehlt etc) an die direkt zuständigen geschickt, also an die Bezirke. Oder direkt an die Magistrate, wenn es ein technisches Gebrechen ist. Aber eigentlich sind die Bezirke zuständig und sonst an die Stadtebene primär über Kampagnen. Und seit 2022 haben wir auch vier Mal im Jahr ein Gespräch mit der Mobilitätsagentur. Das ist ein Netzwerktreffen, wo halt viermal im Jahr 1,5 Stunden Zeit ist, um alle Themen zu besprechen. Genau da beschränken wir uns halt vor allem auf diese Metaebene oder generische Probleme. Also zum Beispiel war Thema, dass die Stadt

Wien diese Zusatz Beschilderung der Einbahn Öffnungen viel zu klein dimensioniert hat. Dann haben wir thematisiert, dass es zu klein ist, und dann haben sie nachher eine aufgeblasene Version gemacht.

Johanna Karl Aber die Informationen in dem Kummerkasten, das ist ja sehr viel Information schon, auch teilweise schon altes. Macht ihr da Auszüge der Problemstellen für die Bezirke?

Radlobby Ja, also früher monatlich, jetzt viermal im Jahr kriegen die Bezirke eine Liste. Wir nennen das Export, ein Dossier zu den neu gemeldeten Problemstellen. Und davon unabhängig schauen unsere Bezirksgruppen hinein, welche Meldungen besonders viele Kommentare oder Likes haben. Und beim Treffen mit der Mobilitätsagentur schauen wir jeweils die 5 bis 10 Top Projekte an, dass wir die vertiefend besprechen, um an die Ursachen zu kommen. Sonst, der Austausch findet also einmal im Jahr bisher, wenn es klappt, quasi auf der Stadtrat Ebene statt. Und was es noch gibt, ist die Fachkommission Verkehr. Wo die Pläne zu neuen Straßen Umbauten hergezeigt werden und die Interessensvertretungen können dann noch sagen das gefällt ihnen oder nicht. Bevor es dann in der Woche danach gebaut wird.

Johanna Karl Und es gegebenenfalls stoppen, oder wie?

Radlobby Das ist noch nicht passiert. Vor allem nicht, wenn es so kurzfristig ist. Wenn es ein Projekt ist, wo man überlegt, ob man das so machen kann, dann gibt es schon Fälle, wo es zurückgestellt wurde, weil Parkplätze verloren gehen. Aber das sind Einzelfälle. Wo mit Unterschriftenaktionen versucht wird, Gegenkampagnen zu starten. Es bestätigt sich auch, dass das eigentlich nicht wirkliche Zukunft hat.

Johanna Karl Ja okay, du hast vorhin angesprochen, das Netz ist kein durchgängiges Netz. Was würdest du sagen, sind die Bauprojekte, die jetzt, die für dieses Jahr angesetzt sind, gehen die an die richtigen Stellen?

Radlobby Konkret oder allgemein?

Johanna Karl Allgemein.

Radlobby Also allgemein haben wir das Radlobby Basisnetz entwickelt und wir schauen dann ob diese Projekte in unserem Netz sind. Das ist so unsere Idee eines Zielnetzes. Wir haben quasi eine voraus Leistung gemacht und uns für die ganze Stadt ein Wunschnetz überlegt. Da haben wir die Jahre der Pandemie genutzt, Workshops gemacht, Karten gezeichnet und so weiter. So haben wir das Radlobby Basisnetz entwickelt, das ist eine öffentliche Karte, wo wir Striche gezeichnet haben, auf die ganze Stadt. Wo wir Routen sehen, nicht konkrete Anlagen oder Randstreifen, sondern nur eine Linie, wo wir langfristig diese Routen durch die Stadt gerne hätten. Da bestätigen wir sehr viel vom Hauptradverkehrsnetz. Aber es gibt auch Routen die sind noch nicht im Hauptradverkehrsnetz. Obwohl sie eigentlich hineingehören. Da sammeln wir jetzt alle Routen pro Bezirk. Und wenden uns dann an die MA18, und an die Ulli Sima, mit Stellen wo das Netz neue Routen braucht.

Johanna Karl Also beispielsweise Argentinierstraße, die jetzt angegangen wird, aber auch in der Donaustadt einige Projekte. Das geht schon in die richtige Richtung?

Radlobby Das waren jetzt die zwei Radschnellverbindungen, die auf jeden Fall, die sind sehr wichtig. Aber es sind ausnahmslos alle Projekte auf dem Radlobby-Basisnetz. Sind also zumindest auf einem Netz, wo aus unserer Sicht langfristig der Radverkehr stattfinden soll. Ob es jetzt die richtige Reihenfolge ist, kann ich jetzt auf die Schnelle nicht sagen. Weil es sehr viele Schlüsselprojekte gibt, die sehr wichtig werden, aber nicht geschafft werden. Und dann macht man halt andere Dinge, die aber nicht so wirksam sind.

Johanna Karl Und weil man auch nicht anders kann, wahrscheinlich, weil der Bezirk ja auch mitredet und dann stockt es.

Radlobby Es gibt auf diesem Prozess viele Stolpersteine und wenn man nicht wirklich dahinter ist, und der Wille etwas zu machen war bisher wirklich sehr überschaubar. Was ich noch sagen wollte, die Hauptnetz Projekte, da gab es eine Analyse, eine TU Wien Studie, im Auftrag der Mobilitätsagentur, die dringendsten Radwege Wiens. In den bisherigen Bauprogrammen der letzten drei Jahre war keines drinnen, was da genannt wurde. Man weiß genau, wo es eigentlich brennt, und müsste viel mehr in diese Richtung gehen.

Johanna Karl Und da scheitert es oft an?

Radlobby Bisher häufig am Bezirk. Einspruch wegen Parkplätzen.

Johanna Karl Eine andere Frage, zu der Online Karte in der ihr das Radnetz bewertet habt, nach den Kategorien gemütlich, stressig etc.

Radlobby Also koordiniert wird das von M. Straub. Wir haben da quasi aus der Community die ganzen Erfahrungen zusammen geschleust. Und das ist wirklich nur eine Empfehlung, wo man aus Sicht der heute Radfahrenden gut durch die Stadt kommt. Mit Qualität stressig bis gemütlich. Aber das beinhaltet keine Zukunftsaussichten, kein zukünftiges Netz. Eigentlich auch keine Lücken. Die kann man nur indirekt ableiten. Weil auch die Stadt Wien keine gute Radkarte hat. Dem wird zwar widersprochen. Aber mit der Karte von der Mobilitätsagentur kann man nicht navigieren. Es ist kein Netz, sondern ein Rendering des Datensatzes der Radfahranlagen. Aber es ist keine Orientierungskarte.

Johanna Karl Ja, aber zum Beispiel das wien mobil App, das hat ja auch die Fahrrad Routing Funktion. Ich finde die funktioniert relativ gut.

Radlobby Ich glaube, der basiert auf der VAO. Und die ist bundesweit gut. Da gibt es auch eine Umstellung. Die arbeiten zukünftig mit Nutzungsstreifen, nicht mehr mit der Straßenachse. Ja das routing funktioniert eh sehr gut. Wir merken nur, dass viele Menschen so ein Bild von Wien bräuchten wo man eine Übersicht hat.

Johanna Karl Vieles weiß man erst, wenn man es selbst ausprobiert hat und das sollte nicht so sein, oder?

Radlobby Genau, stell dir vor, du würdest mit den Öffis in Wien fahren, und hättest keine Karte. Also, ja das ist wirklich auffällig, wenn Menschen fragt Wie kommen sie wohin, können sie mit der Radkarte derzeit nicht viel anfangen. Es sind zwar Linien aber kein Netz.

Johanna Karl Ist die Beschilderung vor Ort vielleicht auch noch etwas, was noch mehr ausgebaut werden könnte oder nicht?

Radlobby Also das gibt es de facto nicht. Es gibt glaub ich 10 000 Schilder, die irgendwo stehen aber aus den 80er und 90er ohne Konzept. Das ist wirklich auffällig. Die Stadt arbeitet seit vielen Jahren schon an einer neuen Beschilderung. Also die Hinweise, wo man fahren sollte die sind noch nicht einmal Teil des Konzepts. Dazu kommt, dass die Radwege nicht selbsterklärend gestaltet sind. Meistens ist es schwarzer Asphalt mit einer Linie irgendwo am Rand. Und vielleicht mit blauen Punkten. Aber so wie es die Dänen machen, oder die Niederländer da weiß man auf den ersten Blick wo man fahren soll. Worauf ich hinaus will, ist das Design und auch was es gibt, ist nicht erkennbar als solches. Auch die neuen Radwege sind ein schwarzes Asphalt Band. Da weiß man jetzt nicht, dass das kein Gehsteig ist.

Johanna Karl Also es bräuchte noch mehr Symbolisierung?

Radlobby Farben. Durchgängige. Also die Niederländer machen rote Farbe auf den Asphalt.

Johanna Karl Wir haben alle Farben.

Radlobby Am Ring meinen wir braucht es zwei Fahrspuren weniger, die Nebenfahrbahnen zu Fahrradstraßen.

Johanna Karl Aber die gibt es ja nicht überall.

Radlobby Fast überall. Wir haben schon 5 Schlüsselstellen identifiziert, wo man eine andere Lösung braucht. Aber auf 90 % der Strecke des Rings gibt es eine breite Nebenfahrbahn mit parkenden Autos.

Johanna Karl Okay, also es fließen verschiedene Faktoren in den Index rein, in die Bewertung und ich muss die verschiedensten gewichten. Und ich habe alle meine Interviewpartner gefragt, ob sie mir das aus ihrer Sicht ranken können, was am wichtigsten ist für ein akkurates Ergebnis in Wien. Also es geht um die lokalen Gegebenheiten. Wie wichtig ist zum Beispiel die Fahrradinfrastruktur für die Gesamtbewertung?

Radlobby Also man muss die Frage stellen, was soll der Index aussagen? Soll das jetzt die Empfehlung sein, auf Basis dessen man die Radlkarte optimiert und bessere Routen durch die Stadt findet, oder soll der Ausbauprojekte der Stadt Wien nahelegen?

Johanna Karl Es soll den Bestand, der aktuellen Situation widerspiegeln. Und ich werde es dann mit den geplanten Projekten vergleichen.

Radlobby Okay. Das heißt, wie gut diese Straße zum Radfahren geeignet ist? Aus Sicht der Stadt als Dienstleistung für die Bewohner so ungefähr?

Johanna Karl Also natürlich ist es ein Modell, dieser Index. Und es ist natürlich auch so, dass das ist der Durchschnitts Radfahrer sozusagen. Ja, also es ist eine Möglichkeit, die Planung zu unterstützen mit so etwas. Und das ist überhaupt auch die Frage des Ganzen. Also hat es überhaupt Potenzial, wird es überhaupt gebraucht?

Radlobby Also es gibt diese große Studie, die Qualitätsbewertung Hauptradverkehrsnetz. Da haben sie schon ganz Wien analysiert. Aber die Studie ist unter Verschluss und bleibt unter Verschluss. Also das wird nicht kommuniziert, weil rauskommt, dass 80% des Verkehrsnetzes nicht für Kinder geeignet sind. Wir wissen das, aber die Öffentlichkeit weiß das nicht. Wien hat 1400 Kilometer Radwege. Das ist die Message, die alle hören und auch jahrzehntelang gehört haben. Also das ist wirklich peinlich und eigentlich höchst kritisch, dass diese Erkenntnisse nicht kommuniziert werden, aus politischen Gründen. Wir haben nur einmal gesehen, dass es das gibt, aber keine Inhalte gesehen. Also man kann es einsehen, aber nichts davon dokumentieren.

Radlobby Infrastruktur ist einfach sehr wichtig. Aber nur, dass eine Linie dort ist, reicht nicht aus.

Johanna Karl Nein, das ist eh klar. Das verstehe ich.

Radlobby Diese Linie kann auch eine Radroute sein. Also ein grünes Schild bei einer Straße mit Tempo 50 ist auch in diesem Datensatz drinnen. Ich würde eine Unterscheidung empfehlen. Einen Datensatz subjektiv sicher und einen Datensatz subjektiv unsicher. Aber sobald es unsicher ist, sind sie hoch zu gewichten. Nachdem in Wien die meisten Steigungen nicht vermeidbar sind, muss ich sie gering bewerten. Es sind auch für die aus wissenschaftlicher Sicht für den Radverkehrsanteil nur von untergeordneter Bedeutung.

Radlobby Also, die Beschilderung ist nice to have. Aber wenn ich einen Radweg habe, der asphaltiert ist, dann ist es zweitrangig, ob das beschildert ist oder nicht. Geringe Anzahl an Kreuzungen. Ist erstaunlich unwichtig, weil die Kreuzungen auch nicht verschwinden werden. Geschwindigkeit, das Tempolimit. Also für uns ist es so, halt bei Tempo 30 ist keine Trennung nötig. Und bei höheren Geschwindigkeiten geht es eigentlich nur noch mit Trennung. Also je nach Trennung ist die Geschwindigkeit wichtig.

Johanna Karl Und wenn ich sage, ich kann nicht unterscheiden zwischen getrennt oder nicht getrennt, dann ist die Geschwindigkeit schon wichtig.

Radlobby Vergleichsweise egal. Stichwort Donaukanal, da hat man einen getrennten Weg und daneben wird Tempo 70 gefahren. Aber eine Unterscheidung von getrennt und nicht getrennt würde ich empfehlen. Anzahl der Fahrspuren, verhält sich eigentlich ähnlich. Grünflächen auch wichtig. Die Dichte der Bebauung. Sprich wie potenziellen Nutzerinnen?

Radlobby Ja, das kann sicher sinnvoll sein. Aber nicht, wo viele Leute wohnen, ist der Radweg gut.

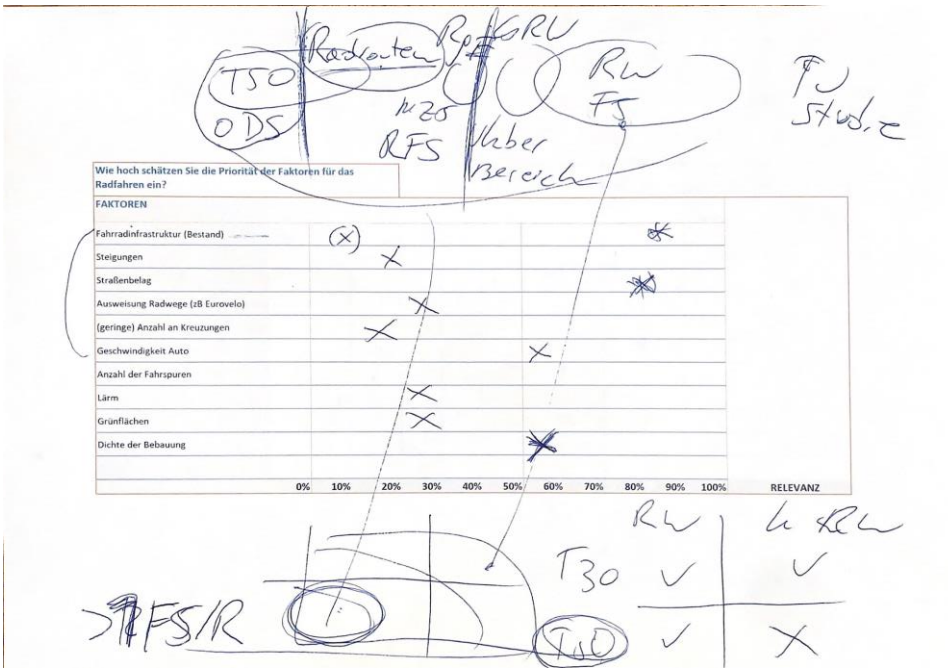
Johanna Karl Stimmt genau. Das ist nicht dasselbe. Okay, danke jetzt bin ich am Ende.

Radlobby Frage noch zur Übertragbarkeit des Wissens in die Praxis. Wie viel davon ist quasi produktiv nutzbar?

Johanna Karl Also bei dem Index geht es eigentlich darum, das zeichnet ihn aus, dass er für alle offen zugänglich ist und reproduzierbar sein soll. Bis jetzt ist es ein Tool, wo man sich schon bisschen auskennen muss. Und da war auch immer die Rückmeldung jetzt, es das darf nicht mehr Arbeit bedeuten. Ja, das muss also irgendwie automatisch passieren. Also das heißt es gibt schon prinzipiell Potenzial, das zu sehen.

Radlobby Ja, Wien hat eben diesen Datensatz von dieser TU Studie, aber ist nicht öffentlich. Es fehlt eine Auswertung. Wenn man das einmal berechnet und dann online stellt. Das kann ich gerne anbieten, dass wir eine Radlobby Berechnung machen. Also das hätte Alleinstellungsmerkmal.

Interview 3: Handout



11.5 Table Literature Review

Table Appendix 1

Analysis of selected studies on bikeability*

Authors by Date	Method	Area	Factors	Spatial unit	Computation
Fahrrad Klimatest ADFC 2022	Qualitative	German cities	Soft	City Level	Verbal
Ito and Biljecki, 2021	Quantitative	Singapor, Tokyo	Hard	Line	Equation
Hardinghaus et al., 2021	Qual./Quant.	Berlin, Germany	Hard	Admin. Level	Verbal
Schmid-Querg et al., 2021	Qualitative	Munich, Germany	Hard	Line	Verbal
Arellana, et al., 2020	Qualitative	Columbia	Hard, Soft	Line	Equation
Gholamialam and Matisziw,	Qualitative	Columbia, MO/ USA	Hard	Line	Equation

Authors by Date	Method	Area	Factors	Spatial unit	Computation
2019					
Mc Arthur and Hong, 2019	Qualitative	Glasgow	Observed/shortest route	Line	Verbal
Grigore et al., 2019	Quantitative	Basel	Hard	Line	Equation
Pritchard et al. 2019 (BLOS)	Qualitative	Trondheim, Norway	Hard/ Route Choice	Line	Equation
Colville-Andersen, 2018	Qualitative	European Cities	Hard	City Level	Verbal
Cain et al., 2018 (MAPS)	Qualitative	5 countries	Hard	Route	Verbal
Loidl et al., 2018	Quantitative	Salzburg	Hard	Grid Cell	Verbal
Boettge et al, 2017	Qualitative	St. Louis, MO, USA	Hard	Line	Verbal
Sallis et al, 2016	Qualitative	14 cities	Hard	Admin. Levels	Verbal
Winters et al., 2016 (BikeScore)	Quantitative	24 cities, US/CA	Hard	Grid Cells	Verbal
Loidl and Zagel, 2015	Quantitative	Salzburg	Hard	Line	Verbal
Gullon et al., 2015 (M-SPACES)	Qualitative	Madrid, Spain	Hard	Line	Verbal
Krenn et al, 2015	Quantitative	Graz, Austria	Hard	Grid Cell	Verbal
Krenn et al.,	Qualitative	Graz,	Observed/sh	Route	Verbal

Authors by Date	Method	Area	Factors	Spatial unit	Computation
2014		Austria	ortest route		
Larsen et al., 2013	Qualitative	Montreal, CA	Hard	Grid Cells	Equation
Lowry et al., 2012 (BLOS)	Quantitative	Moscow, Idaho, US	Hard	Line	Equation
Winters et. al, 2012	Qualitative	Vancouver, CA	Hard	Grid Cells	Verbal
Wahlgren et al., 2010 (ACRES)	Qualitative	Stockholm, Sweden	Hard/Soft	Line	Verbal
Hoedl et al., 2010 (BiWET)	Qualitative	Graz, Austria	Hard	Line	Verbal
Dill and Car, 2003	Qualitative	43 US cities	Hard	Admin. Levels	Verbal
Landis et al., 1997 (BLOS)	Qualitative	Tampa, Florida, US	Hard	City level	Verbal

Note. Based on a literature review. * Criteria for selection: geographic variability, citations

11.6 Table District Analysis

Table Appendix 2

Analysis of Streets per District, Hit Rate of Index and additional meters with Low B.

District	Low B. + in Planning	Low B. + not in Planning	In Planning + not Low B.	Est. Hit Rate %	Potential m
1.	Getreidemarkt (bis Gauermanng.)	Wipplingerstraße Hohenstaufengasse (letzte Abschnitte)	Johannesgasse	50%	160
2.	Taborstraße (bis Blumauerg.)	Taborstraße (bis am Tabor) Gredlerstraße	Lassallestraße Leopoldsgasse Stemmerallee/Ostbahnbrücke	20%	1150
3.	Ungargasse Fasangasse Rennweg Ergbergstraße Arsenal Franzosengraben	Schlachthausgasse Franzosengraben Rennweg Ghegastraße	Arsenal Ghegastraße Hafengasse Oberzellergasse Löwengasse	60%	2180
4.	Favoritenstraße	-	Wiedner Hauptstraße Favoritenstraße Schönburg/ Klagbaumgasse Rainergasse/ Belvedereg	10%	-
5.	Magaretengürtel	Abschnitt Magaretenstraße	Rechte Wienzeile Grünwaldgasse	25%	80
6.	-	Hofmühlgasse bis Mollardgasse	-	-	140
7.	-	Kaiserstraße Westbahnstraße	-	-	5050

District	Low B. + in Planning	Low B. + not in Planning	In Planning + not Low B.	Est. Hit Rate %	Potential m
		Siebensterngasse Breitegasse Lerchenfelderstr.			
8.	Florianigasse (zw. Albertg./Feldg.)	Josefstädterstraße Laudongasse Langegasse (Lerchenfelderstr.)	Alserstraße (Skodag. Bis Langeg.) Abschnitt 2er Linie	20%	2310
9.	Währingerstraße (Gürtel bis Spitalg.) Porzellangasse Heiligenstädterstr.	Nußdorferstraße (Gürtel bis Schubertg.) Liechtensteinstr. (Koling. Bis Thurng.)	Schlickplatz Spittelauer Lände Tepserng. Nordbergstr./Nordbergbrücke	40%	1420
10.	Triester Str. (Davidg. Bis Matzleinsd. Pl.) Gudrunstr. (Sonnwendg. Bis Matzleinsd. Pl.) Neilreichgasse partly Laxenburgerstr. Laer-Berg Straße Troststraße teilw. Grenzackerstraße Davidg. Teilw.	Laxenburgerstraße Triester Str. Wienerbergstr. Knöllgasse (kl. Abschnitt) Feldwege Goldberg (skip)	Neilreichgasse Gußriegelstraße Clemens Holzmeister-Straße Herndlgasse Marianne Polak G. Leopoldsdorferstr. Landgutg. Davidgasse Trostraße An der Ostbahn Puchsbaumg. Rosiwaldg. Rothneusiedel Indigoweg/Liesingbachstr. Oberlaaer Str.	30%	6400
11.	Kopalg. (small segm.)	Hauffgasse Simmeringerhauptstr.	Simmeringerhauptst. (Südostt. Bis	5%	1030

District	Low B. + in Planning	Low B. + not in Planning	In Planning + not Low B.	Est. Hit Rate %	Potential m
	Geiselbergstr. Simmeringerhauptst. (small segement)	(Awarenstraße)	Zippererstr.) Kopalg. Haidestr./Neurissen weg Simmeringer Lände Alberner Hafenzufahrtsstr. Kaiserebersdorferstr. Awarenstr. Kleingartenanlage Awaren 11. Haidequerstr.		
12.	Altmannsdorferstr. Hetzendorferstr. Breitenfurterstr. Eichenstr. Grünbergstr. Stiegerbrücke	Aßmeyergasse Graf Seiler G./Edelsinnstr. Sagedergasse Wienerbergstr.	Altmannsdorferstr. Rechte Wienz. 223-227 Niederhofstr./Böckhg. Vivenotgasse Eibesbrunnerg. Am Schöpfwerk Hetzendorferstr. Wundtg.	60%	4200
13.	Lainzerstr. 55-83 Hietzingerhauptstr. 20-26 Stranzenbergbrücke	Fasangarteng. 84-98 Hietzinger Hauptstr. 60-88 (Wientalstr.)	Speisingerstr. Feldkellerg. Lainzerstr. Schrutkagasse Mantlerg. Wolkersbergenstr. Rotenbergg. Heinz Nittel Weg Hummelgasse	5%	670

District	Low B. + in Planning	Low B. + not in Planning	In Planning + not Low B.	Est. Hit Rate %	Potential m
14.	Linzerstr. 1-36; 376-420 Hütteldorferstr. 102-124	Hauptstraße 142-180 Reinlgasse Breitenseer Str. 20-50	Hauptstr. 37-91 Mauerbachstraße 2-24 Utendorfg. Flötzlsteig Baumgartner Höhe Ameisbachzeile Deutschordenstr. Müller Gutenbrunn str. Linzer Straße Penzingerstr. 2-68 Cumberlandstr. 41-53 Goldschlagstraße 128-144	5%	3012
15.	Stiegergasse	Camillo Sitte G. Märzstraße/Huglgasse SechshauserStr. 1-40 Anschützg. 1-5	Ullmannstr. Linzerstraße hinter TM Grenzgasse Schmelzbrücke Hütteldorferstr.44-76 Minciostraße Stutterheimstr. Schweglerstraße	5%	2030
16.	Ottakringerstr. 106-188 Wernhardstr. - Spetterbrücke	Neulerchenfelderstr. Thaliastraße 56-158 Panikengasse Herbststr. 52-72 Habicherg. 1-11 Possingerg.	Ameisbachzeile Demuthgasse Reizenpfennigg. Maroltingerg. Gablenzg. Blumbergg.	40 %	7280 (1000)

District	Low B. + in Planning	Low B. + not in Planning	In Planning + not Low B.	Est. Hit Rate %	Potential m
		Rankgasse 2-20 Wilheminenstr. 10-92 Sandleiteng. 37-47 (Pelzer Rennweg)			
17.	Hernalser Hauptstraße 76-100	Mayssengasse Hormayrgasse Güpferlingstr./ Hernalser Hauptstr.	Hernalser Haupstraße 100 – 170 Dornbacherzeile Alszeile Amundsenstr./Neuwaldeggerstr.	5%	1480
18.	Türkenschanzplatz Brücke Station Gersthof	Währingerstr. 164-206 Gersthoferstr. 4-30 Hockegasse 2-30 Max Emanuel Str. Pötzleinsdorferstr. 62-102 Khevenhüllerstr.	Kreuzgasse Währingerstr. 82-162 Gentzgasse 110-136 Anastasius Grüng. 2-6	2%	3050
19.	Billrothstr. 22-76 Grinzingerstr./Heiligenstädterstr. Crossing	Döblinger Hauptstr. 2-44 Billrothstraße 2-18 Barawitzkagasse Silbergasse 1-17	Krottenbachstr. (Obkircherg. Bis Felx Dahn Str.) Görgeng. 2-12 Sieveringerstr. 2-36 Grinzingerstr. Sandgasse Hohe Warte 31-45 Heiligenstädterstr. 3-79 und 157-179 Döblingerhauptstr. 27-95 Rathstr./Hameaustraße	5%	2335

District	Low B. + in Planning	Low B. + not in Planning	In Planning + not Low B.	Est. Hit Rate %	Potential m
20.	Adalbert Stifter Str. (Friedrich Engels Platz – Lorenz Müller G.) Wallensteinplatz	Rauscherstraße Dammstraße Adalbert Stifter Str. (ab Donaukanal) Dresdnerstraße 1-21 Pasettistraße	Wallensteinstraße Jägerstraße 29-69 Dresdnerstr. Hellwagstr. Nordwestbahnstraße 3-33	20%	2850
21.	Pragerstr. Brünnerstr. Eipeldauerstr. Leopoldauerstr. Donaufelderstr.	Jenneweing. Anton Bosch G. Brünnerstr. From 295	Wagramerstraße Scheydgasse Dr. Nekowitsch Str. Autokaderstr. Josef Flandorf Str. Stammersdorferstr. Illgasse Pinkagasse Seyringerstr. Julius Ficker Str. Donaufelderstr. Fultonstr. An der oberen alten Donau	30%	2950
22.	Erzherzog Karl Str. Donaustadtstr. Wagramerstr. Mayredergasse	Wagramerstr. Siegesplatz/Asperner Heldenpl.	Rennbahnweg Wagramerstr. Bettelheimstr. Blankenmaisstr. Lina Los Platz Franz Wels g. Sonnenallee Hausfeldstr. Berresg.	20%	1580
23.	Laxenburgerstr.	Triesterstr. (but	Tenscherstr.	15%	3000

District	Low B. + in Planning	Low B. + not in Planning	In Planning + not Low B.	Est. Hit Rate %	Potential m
	Perfektastr. Breitenfurterstr. Erlaaerstr. Hetzendorferstr. Altmannsdorferstr.	parallel in planning) Ketzerg. Brunnerstr.	Heizwerkstr. Halban Kurz Str. Oberlaaerstr. Krawatschg./Kinskyg Goldhammerg. Erlaaerstr. Hetmanekg. Karl Tornay G. Talpag. Siebenhirtenstr. Seybelg.		

Note. Based on NetAScore, Mobility Lab, Loidl et al.

11.7 Excel Analysis (extracted)

BEZ	In Planung	High Bikeability (>=0,68)	Low Bikeability (<=0,49)	Gesamt-länge	Not in Planning and LOW	Anteil an Gesamtlänge	Anteil LOW	Anteil HIGH	HIT RATE
01	580	9545	115	38475	160	0,42%	0,30%	24,81%	50%
02	3910	26274	8776	133946	1150	0,86%	6,55%	19,62%	20%
03	7550	15388	7211	82123	2180	2,65%	8,78%	18,74%	60%
04	3267	3642	1046	16889	0	0,00%	6,19%	21,56%	10%
05	1813	3155	1299	25114	80	0,32%	5,17%	12,56%	25%
06	33	1274	170	18356	140	0,76%	0,93%	6,94%	0
07		1132	2859	16289	5050	31,00%	17,55%	6,95%	0
08	1059	374	2577	12949	2310	17,84%	19,90%	2,89%	20%
09	3531	5916	1873	39437	1420	3,60%	4,75%	15,00%	40%
10	24910	29921	22670	230723	6400	2,77%	9,83%	12,97%	30%
11	12932	23670	2976	167561	1030	0,61%	1,78%	14,13%	5%
12	10375	16550	9371	87368	4200	4,81%	10,73%	18,94%	60%
13	10785	7771	8472	131439	670	0,51%	6,45%	5,91%	5%
14	16244	9173	27723	212940	3012	1,41%	13,02%	4,31%	5%
15	3711	2126	2550	44311	2030	4,58%	5,76%	4,80%	5%
16	3385	3659	6347	80315	7280	9,06%	7,90%	4,56%	40%
17	5305	4002	15096	82385	1480	1,80%	18,32%	4,86%	5%
18	3313	3678	2104	66414	3050	4,59%	3,17%	5,54%	2%
19	12603	3024	12113	144321	2335	1,62%	8,39%	2,10%	5%
20	5269	14766	6297	59936	2850	4,76%	10,51%	24,64%	20%
21	27837	42239	13479	351505	2950	0,84%	3,83%	12,02%	30%
22	38360	67168	43637	593412	1580	0,27%	7,35%	11,32%	20%
23	33533	20241	22420	227366	3000	1,32%	9,86%	8,90%	15%

Eidesstattliche Erklärung

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11.11.2023 J. Karl

Date Signature