FACULTY OF ENGINEERING
AND ARCHITECTURE

PERSPECTIVE ON SPATIAL-QUANTITATIVE AND QUALITATIVE ASSESSMENTS OF ‘THE BICYCLE SYSTEM’

Féline De Pandelaere
Student number: 0161152

Supervisor: Prof. Dr. Ir. Rob Van der Bijl
Counsellors: Dr. Lucas Harms (Dutch Cycling Embassy), Ir. Pepijn Verpaalen (Gemeente Amsterdam), Ir. Maurits Lopes Cardozo (Bike-minded)

Academic year 2021–2022

GHENT
UNIVERSITY

FACULTY OF ENGINEERING
AND ARCHITECTURE

Perspective on spatial-quantitative and qualitative assessments of ‘the bicycle system’

Féline De Pandelaere
Student number: 0161152

Supervisor: Prof. Dr. Ir. Rob Van der Bijl
Councellors: Dr. Lucas Harms (Dutch Cycling Embassy), Ir. Pepijn Verpaalen (Gemeente Amsterdam), Ir. Maurits Lopes Cardozo (Bike-minded)

A dissertation submitted to Ghent University in partial fulfilment of the requirements for the degree of Master of Science in Civil Engineering

Academic year: 2021 - 2022

GHENT
UNIVERSITY

Preface

First and foremost, I would like to take this opportunity to express my gratitude to a number of people. In particular, a heartfelt thank you to my supervisor and professor Rob Van der Bijl, without whom my master's thesis could not have been completed to the extent it is presented today. He was always available to answer questions, schedule a meeting and has provided me with tons of information to research and enlarge my knowledge about the bicycle system and mobility in general. Furthermore, he arranged a tour around Haarlemmerdijk in Amsterdam, so I got the opportunity to experience the exceptional local bicycle system myself. Subsequently, he provided me with video material to be able to make a more detailed analysis afterwards. Secondly, I would like to thank my counsellors Lucas Harms, Pepijn VerPaalen and Maurits Lopes Cardozo who dedicated their time and expertise in providing me with relevant feedback and guidance. Thirdly, I would like to thank the experts that have engaged themselves in this master's thesis by giving their insights, suggestions and providing me with useful data on the case studies and further documentation for the general scope of this master's thesis. Thank you for your time and dedication, Joris Van Damme, Fabian Van De Velde, Olv Klijn and Kees Vernooij.

Furthermore, I would like to thank Otto Van Boggelen who answered my questions regarding the CROW-width label tool, Wies Callens from Fietsberaad Vlaanderen for the inspirational call and Jaap Kamminga of the Nederlandse Fietsersbond to further explain their Fietsstadverkiezing and give feedback on my qualitative analysis.

In my personal circle, I would like to thank my fellow students and friends for providing me with support and helping me to persevere in my work. On this behalf, I would like to dedicate an extra thank you to Pieterjan Bonte who allowed me to borrow his computer in order the run all simulations. Lastly, I would like to thank my grandmother and parents for giving me the trust and opportunity to complete my studies at Ghent University.

Permission of Use

11^{th} *of June*, 2022
Féline De Pandelaere

Abstract

Perspective on qualitative and spatial-quantitative assessments of 'the bicycle system' - *Féline De Pandelaere*

This master's dissertation was written with the aim of creating a perspective on qualitative and spatial-quantitative assessments of the bicycle system in Europe. The main objective is to analyse the available tools and methods to assess the system with respect to their resilience in terms of changing cycling composition and road space scarcity. First, an extensive literary review is provided. The latter provides a clear definition of the bicycle system and describes its characteristics and parameters. Furthermore, its history and contemporary developments are discussed. Concerning the analyses, twenty tools assessing the quality of bicycle systems have been analysed. Afterwards, a categorisation is provided, as well as suggestions in order to improve them. A remarkable result holds the lacking of spatial-quantitative assessments. As a result, the second part of this master's dissertation focuses on quantitative methods in road space allocation. Several methods are discussed after which case studies are performed on Haarlemmerdijk in Amsterdam, The Netherlands and Coupure Links in Ghent, Belgium. Designs have been compared and sensitivity analysis have been performed. Finally, four experts have been interviewed in order to implement their insights and suggestions. To conclude, recommendations have been drawn up with respect to further research and the improvement of the tools.

Keywords – *The Bicycle System, Assessments, Spatial-Quantitative and Qualitative, Changing Cycling Composition, Road Space Scarcity*

Supervisor: *Prof. Dr. Ir. Rob Van der Bijl*
Counsellors: *Dr. Lucas Harms (Dutch Cycling Embassy), Ir. Pepijn Verpaalen (Gemeente Amsterdam), Ir. Maurits Lopes Cardozo (Bike-minded)*

Perspective on qualitative and spatial-quantitative assessments of the bicycle system

Féline De Pandelaere

Supervisor: Prof. Dr. Ir. Rob Van der Bijl
Counsellors: Dr. Lucas Harms (Dutch Cycling Embassy), Ir. Pepijn Verpaalen (Gemeente Amsterdam),
Ir. Maurits Lopes Cardozo (Bike-minded)

***Keywords* – The Bicycle System, Assessments, Spatial-quantitative and qualitative, Changing Cycling Composition, Road Space Scarcity**

I. INTRODUCTION

"If you build it, they will come", a popular phrase in the world of urban planning, cycling specialists and activists. Although, this statement has been proven by many positive outcomes in cities all over the world, it is important to not just consider the infrastructure when trying to increase bicycle usage. Nevertheless, the whole bicycle system, all of its requirements, limits and influential parameters have to be fully understood in order to enable a sustainable change. As a result, the availability of accurate assessment tools and methods is of crucial importance.

The attention and interest towards cycling -from the general public as well as from the expert side- has risen exponentially over the past years. This is due to several reasons among which the official European recognition of the importance of cycling and the recent Covid-19 crisis. Furthermore, the absolute numbers of cyclists are increasing, as well as their increasing multi-modality. Taking into account the scarcity of road space that is being experienced in European urban environments, it is clear that effective and consistent policies are needed with respect to the design of the entire bicycle system. Nevertheless, this is not evident. A wide variaty of -very different- tools is available to qualitatively asses the bicycle system. Furthermore, there is only a limited amount of methods to assign road space to the system. As a consequence, this master dissertation will try to provide guidance on this regard, as well as recommendations in order to improve the tools, with respect to further research and to implement directly. All of this, by taking into account the contemporary developments that are stressing the existing bicycle system.

II. METHODOLOGY AND RESEARCH QUESTIONS

A. Research Questions

Due to the knowledge gap in between research and effective cycling strategies, and due to the combined effect of space scarcity in urban environments with the increasing variety of cycling multi-modality, it was chosen to check the available methods and tools towards there resilience of these developments. Furthermore, a pratical application will be performed on two case studies for the spatial-quantitative methods. The latter with a major focus on road space and capacity. The main topic and the two sub-questions are provided below. *Analysis of the resilience of available tools and methods to assess and design the bicycle system in Europe: (1) What are the available tools to qualitatively evaluate the bicycle system and - given its stated definition, components and contemporary developments - how accurate are they? (2) How is road space, dedicated to the bicycle system, determined quantitatively - and how resilient are the methods with respect to the contemporary developments?* All analyses are performed under the assumption of a definition of the bicycle system according to hardware, orgware, softwaren and context.

B. General Approach

In the first part, twenty qualitative assessment tools have been analysed. Subsequently they have been categorised and the strong and weaker points have been identified as green and red 'flags' respectively. Based on these results, conclusions are drawn. The analysis of twenty tools with varying origin (European, Dutch, Belgian, etc.) was assumed to be sufficient to come to representative conclusions.

The second part holds the spatial-quantitative analysis of the bicycle system. First, four different methods to allocate road space to the bicycle system are identified: based on static guidelines, based on tools, based on cycling behaviour and dynamic road allocation. Finally, the tools are applied to two cases: Coupure Links in Ghent, Belgium and Haarlemmerdijk in Amsterdam, The Netherlands. The latter corridor was chosen due to its exceptional dual character, being a pass through and a destination. Furthermore, it is a highly stressed corridor with a wide variety of cyclists, thanks to the incomparable bicycle system of The Netherlands and Amsterdam. Coupure Links in Ghent was chosen because the corresponding bicycle system and user composition are comparable to those of other NW European cities, e.g., Munich. By using one of the tools, the CROW-width tool, the capacity is defined, and sensitivity analyses are performed with respect to a changing user composition of cyclists. Furthermore, several design options are compared.

Lastly, the conclusions that were drawn up have been discussed with four experts: two Belgian; Fabian Van De Velde (Stad Gent), Joris Van Damme (Vlaams-Brabant) and two Dutch; Kees Vernooij (Stad Amsterdam) and Olv Klijn (FABRICations). Their insights and practical suggestions have been added to the discussions.

III. QUALITATIVE ASSESSMENTS OF THE BICYCLE SYSTEM

A. *General Typology*

As has been mentioned, the variety of the twenty qualitative assessment tools that have been analysed was enormous. Therefore, distinctions had to be made in order to come to a typology. The following levels are identified: *Bicycle system or cycling benefits? Evaluation or ranking? Current state, ambition or growth: are the concepts mixed and clearly defined? The origin of the tool? Internal insights or external comparison? Choice of scope and scale? Parameters taken into account? Used data? Calculation method?* It was noted that this list of attention points in not exclusive. The points were chosen as they were reflected from the literary review. Furthermore, in order to be fully correct, weights should be assigned to all distinctions, as some of them are of far greater importance.

The following general typology was made. The full master's dissertation provides a full overview of the three identified types. Therefore, one is referred to chapter 4.

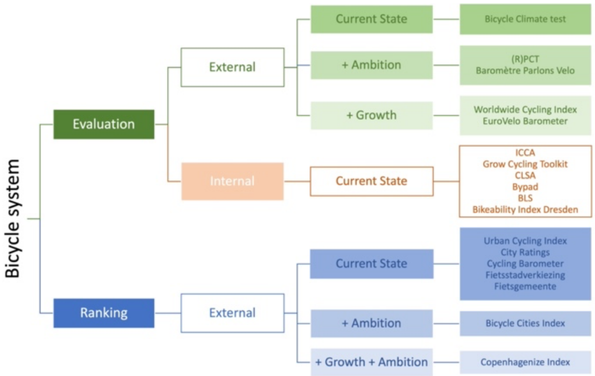


Figure 1: Typology Qualitative Assessment Tools

B. *Detailed Comparison*

For each of the distinguished types, a more detailed analysis was performed for all of the tools based on the identification of green flags (Inclusion of network or accessibility, the use of local data, inclusion of a quantitative analysis, inclusion of the full HSO definition, inclusion of the modal split) and the red flags (company offering services related to cycling, mixing of ambition and growth with current state, no transparency, a narrow definition of infrastructure). The aim of this analysis holds the reveal of which tools have similar methods and thus their results can be compared.

The most surprising finding of the analysis was the fact that zero out of the eighteen remaining tools include all characteristics of the bicycle system -and its evaluation- that have been identified as most important. As a consequence, four tools have been indicated as the most encompassing ones without implying important warning signs or red flags: ICCA, BYPAD, Fietsgemeente and Fietsstadverkiezing.

The first two are BYPAD and ICCA. Both have been categorised as internal evaluation tools and lack a quantitative analysis. Nevertheless, this does not have to outweigh the accuracy of the results. It is concluded that both tools are comprehensive methods in order to assess the current state of a bicycle system and in order to identify growing potentials. On top of this, the results of the analyses should be comparable. The other two tools are classified as rankings of the bicycle system and hold the election of cycle city of the year in respectively The Netherlands and Belgium. They are not comparable as their approaches are completely different and they focus on a different scope. The Flemish one concerns a detailed audit, while the Dutch one concerns a number of parameters that are either assessed by a quantitative calculation or by a survey. Furthermore, the modal split is not considered in the Dutch assessment. The latter parameter was an important point of discussion when the experts were included. It was finally concluded that both the modal split and low speed zones should be included in the analysis as they are interconnected and influence each other. Nevertheless, they indicate different things. Furthermore, it is clear that often a too big focus is layed upon the cycleways themselves while low speed zones easily facilitate this.

The next striking outcome is the rather negative reflection of the Copenhagenize index, as it is by far the mostly spread and known tool. One the one hand its objectivity is questionable, but on the other hand it can be concluded that the tool has been able to create great incentive among cycling cities.

Subsequently, it is noted that almost none of the assessments have included quantitative analyses. As was mentioned, the space scarcity and increasing variety of cyclists are stressing the bicycle system due to which it should actually be one of the priorities. As a consequence, the chapter of spatial-quantitative assessments has been introduced.

To conclude, it is clear that not all qualitative assessment tools are representative with respect to the current establishment of bicycle systems over Europe. Furthermore, it is not possible to compare the results of different assessments due to the wide range of methodologies and the big difference in parameters that are assessed (ranging from 1 to 26) - except for ICCA and BYPAD. Thirdly, it is noted that none of the experts were familiar with all of the tools, but that they were satisfied with the overview and categorisation that have been provided.

IV. SPATIAL-QUANTITATIVE ASSESSMENTS OF THE BICYCLE SYSTEM

This chapter will first give an overview of available methods in order to allocate, share or distribute road space among cyclists or among traffic in general. Several static guidelines from over Europe, methods based on cycling behaviour and dynamic space allocation are briefly discussed. Furthermore, three tools are highlighted; the streetspace design and intervention tools of MORE, the new cycle route quality criteria from Transport for London and the CROW width-label tool are discussed. It is the latter tool which is most interesting and according to which the case studies are performed. It holds an extension of the introduction of width-labels by CROW. Based on predefined minimal width requirements and an analysis of hindrances and dangerous encounters, a width label is assigned to cycleways corresponding to their capacity. It can be said that the method is thus 'spatial-qualitative' as it includes the perception of hindrances and dangerous encounters depending on the intensity and the composition of cyclists, being duocyclists, wide bicycles, mopeds and cylclists in the main direction. For the two case studies, several designs are compared based on a sensitivity analysis of the four parameters that were mentioned. The output holds a matrix in which the intensity is identified in discrete steps in terms of the share of the considered parameter. For each possible combination, the resulting hindrances width label is identified. Finally, the capacity is defined as the intersection between width label B and C. Also, for each design the capacity lines are drawn up with respect to the same parameters, an example is represented in figure 2. Furthermore, a practical application is performed on sample measurements that have been conducted. This on the contrary to the theoretical analysis that are performed by assuming the average values that followed from the design of the tool.

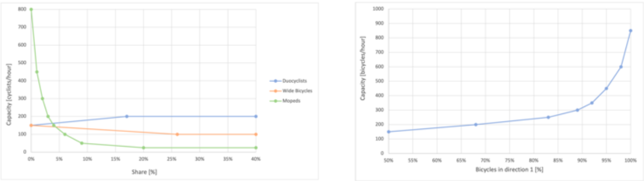


Figure 2: Capacity lines - Current design Coupure Links

It was concluded that the capacities corresponding to the current designs do not fulfil the measured intensities and that ultimately interventions should be taken to increase the comfort of cyclists. Furthermore, the influence of mopeds is proven to be significant. Especially on Haarlemmerdijk, this was a remarkable conclusion as theoretically, mopeds are not allowed to drive on the street. In extension of this, the comparison is made with respect to type 2 e-bikes (bikes which has a gas handle and not solely pedal assistance, as a result also faster, and possibly wider) and especially fatbikes. The latter is done because the fatbikes are proven to reach the same speed in urban environments as mopeds and they have an enlarged with. It is noted that approximately the same number of mopeds and fatbikes were present at Haarlemmerdijk during the sample extraction, due to which an exponential influence with respect to the capacity doubles.

Subsequently it is noted that the capacity defined by the CROW-tool might be rather conservative as the values are already rather low and should in practice be corrected even more due to the presence of cars, due to the obstructions of Haarlemmerdijk originating from (un-)loading vehicles and due to spatial-qualitative considerations of cyclists, pedestrians and motorized traffic that is crossing the corridor. This has not been practically applied during the course of this dissertation as not enough research has been performed based on these aspects. Nevertheless, the tool inherently assumed effective cycling behaviour, which is in practice not the case, see figure 3.

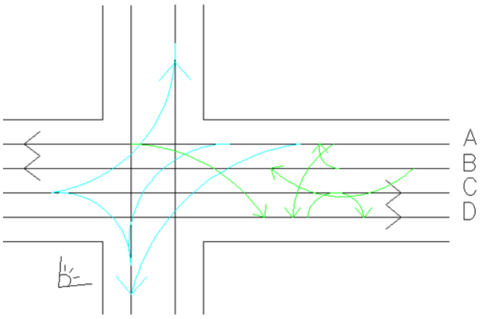


Figure 3: Real cycling behaviour Haarlemmerdijk

The elaborate discussion related to the sensitivity of the case studies as well as the proposed design suggestions are not explained in this abstract, as the goal of this master's dissertation did not entail the case studies themselves. Nevertheless, they can be found in chapter 5.

V. RECOMMENDATIONS AND CONCLUSIONS

The general conclusion with respect to the qualitative assessments of the bicycle system holds that there is a need for all encompassing methods that are transparent and openly available. The recommendations that are made towards the adaptation of existing tools and the design of future methods are the following:

1. Include the full definition of the bicycle system; hardware, orgware, software and context. This is the only way in which the results are representative.
2. Make a clear distinction between the evaluation of the current state, growth over time and ambition in order to get a meaningful ranking.
3. Include the modal split. This parameter represents a clear image on how the cycling climate is established at a certain location, regardless of the cycling facilities that are available. If possible, include the multi-modality of cycling in this modal split.
4. Concerning cycling facilities; do not solely focus on cycling paths, but take into account space sharing. This is important as cycle paths do not solely form the cycling climate. One the one hand, it has been established that great cycling environments can exist without dedicated cycle paths, but e.g. under the

generation of bicycle streets or low speed zones. On the other hand, a lot of cycling paths might be available which are not sufficient and as a result have a negative influence on the cycling climate.

5. Avoid 'bonus points' and keep the focus on objective and transparent parameters. The reader should clearly be able to understand what analyses have been performed and what parameters have been evaluated.

Furthermore, it has been assessed that the qualitative tools are meaningful. They create added value by bringing attention to the bicycle system and by creating great incentive. Nevertheless, they would become more accurate if the above mentioned recommendations were to be implemented and subsequently, a greater attention would be given to the implications of the contemporary developments that have been identified.

Subsequently, attention was paid to accuracy and objectivity concerning data. In this regard, it was noted that the data, obtained in the assessments that were analysed to define the quality of a system, were often not used in a quantitative way. This absence results in a need towards spatial-quantitative assessments in order to be able to analyse the 'spatial-qualitative' side of the bicycle system.

As a result, the second part of this master's dissertation focused on the spatial-quantitative design of cycleways. In general, the following recommendations are made in the field of road space allocation with respect to cycling and cycleways.

1. Take into account multi-modality with respect to the users of the cycleway, both in interventions and designs. Therefore, it is suggested to perform measurements at locations that are expected to be critical.
2. More research is required with respect to the influence of the increasing amount of fast bicycles on the capacity. Especially type 2 e-bikes should be focused upon.
3. Further research and case studies should be performed with respect to the possibility space sharing. The latter for different combinations and types of traffic. Also the consequences with respect to capacity and design should be identified.
4. The same holds for cycling behaviour in general
5. Design guidelines (static and based on the application of tools) should provide alternative design options to apply in dense urban environments. Note that for this recommendation, the research that has been suggested is necessary.

With respect to the CROW width tool, it is concluded that it should encompass more aspects of cycling behaviour, once research is available in the future. This will help to accurately assess the spatial-quality and capacity of a specific corridor.

In general, it can be concluded that no clear solution will soon be provided in terms of urban space scarcity in the field of cycling. The same holds for effective strategies to design and enhance the bicycle system in a resilient way with respect to the contemporary developments. Research is still ongoing and is necessary before practical solutions can be suggested. In particular, research with respect to cycling behaviour and the spatial-quality and -quantity of road space will be of great importance in order to sustain and improve bicycle systems in urban environments in Europe. Furthermore, research towards the influence of type 2 e-bikes has to be conducted. The latter should be accompanied with a focus on the multi-modality of cycling in the academic world. As a matter of fact, this multi-modal way of performing measurements as well as an increased focus on the influence of mopeds can already be practically implemented. In the design of new road systems, this can be taken into account. Furthermore, while awaiting the important research of cycling behaviour, the available qualitative assessments could be optimised by implementing the proposed recommendations. Consequently, they can enlarge their impact in rising incentive in countries/cities/municipalities, spread knowledge through all encompassing tools of the bicycle system and help local councils reach the next cycling level.

VI. ACKNOWLEDGEMENTS

On this regard, I would like to thank my supervisor Rob Van der Bijl for his consistent support and for the inspiring meetings and feedback that I have received. Furthermore, I would like to thank my counsellors for their time and dedication Lucas Harms, Pepijn Verpaalen and Maurits Lopez Cardozo. Lastly, a heartfelt thank you towards the four experts who have provided me with insights and enhanced my research by their in the field experience; Kees Vernooij, Olv Klijn, Fabian Van De Velde and Joris Van Damme.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

”If you build it, they will come”, a popular phrase in the world of urban planning, cycling specialists and activists. Although, this statement has been proven by many positive outcomes in cities all over the world, it is important to not just consider the infrastructure when trying to increase bicycle usage. Nevertheless, the whole bicycle system, all of its requirements, limits and influential parameters have to be fully understood in order to enable a sustainable change [65] [57]. As a result, the availability of accurate assessment tools is of crucial importance. Therefore, this master’s dissertation will provide an academic perspective on qualitative and spatial−quantitative assessments and tools of the bicycle system.

The attention and interest towards cycling -from the general public as well as from the expert side- has risen exponentially over the past years [101]. Different research projects have been funded from the European Union and cycling has become a part of sustainable urban mobility planning. Furthermore, cycling has officially been declared as a climate friendly transport mode. Ministers have called upon the Commission, Member States and local and regional authorities to consider a number of actions in that regard [19]. As a result, more countries and cities are actively contributing in incentives like Eurovelo, Velocity and ECF in order to learn more about and enhance their bicycle system. The Covid-19 crisis has lead city councils in taking accelerated pro-cycling measures [1] and has enlarged bicycle sales [97]. In addition, environmental awareness is increasing and the motivation for a modal shift in transport is bigger than ever [110]. An example of this increased interest holds the big increase of tactical urbanism practices. More specifically in Brussels, several (temporal) cycleways have been introduced without a permit in order to improve local conditions [90].

All previously considered facts are increasing the total amount of cyclists in Europe [56]. Nevertheless, this comes with certain challenges, especially when urban environments are considered. Room for expansion of infrastructure and public space is scarce [54] and it is unclear what the next big steps should hold in order to enhance the cycling climate.

The purpose and added value of this perspective on qualitative and spatial-quantitative assessment entails different aspects. First of all, literature with respect to the bicycle system is inconsistent with respect to definitions, guidelines, best and worst practices, parameters, assessments and so on. Here, an overview will be provided that is generated from different perspectives and aims to be all encompassing. Furthermore, knowledge is lacking with respect to the effectiveness of cycling policies in improving a system. In light of this, qualitative assessments tools can have a very positive impact. Consequently, for the second part; an extensive overview of twenty available tools that analyse the quality of the bicycle system is provided.

Furthermore, a typology will be made in order to clarify what the different tools entail, what they do not and how they should be interpreted or applied. When diving into bicycle system the assessments, it is immediately clear that there is a lack of spatial-quantitative assessments. Therefore, the third focus of this thesis will be on the spatial-quantitative aspect of road space. Furthermore, the capacity of cycleways will be applied on case studies in Amsterdam, The Netherlands and in Ghent, Belgium. The chapter will try to link the spatial-quantitative and spatial-qualitative aspects.

The final result will hold recommendations with respect to further research, possible improvements for the tools, suggestions towards the performed case studies and towards practical policy objectives. Note that in order to obtain realistic insights into the analyses that have been performed, four experts have been contacted.

The upcoming chapter will provide the background of this master dissertation, after which the explicit research questions and methodology will be explained elaborately in chapter 3.

Chapter 2

Literary Review

This chapter is dedicated to provide a framework with respect to the analyses that will be conducted. It starts from the general perspective of cycling within mobility and space and will then deep-dive into the definition, characteristics and benefits of 'the bicycle system'.

The second section provides an overview of the evolutions that have been -and that are currently still- happening in Europe. History, guidelines and contemporary developments and challenges are focused upon.

2.1 Introduction to 'the Bicycle System'

2.1.1 Mobility and Space

Before defining the bicycle system, it is important to understand its place in the broader framework of mobility and space. Mobility concerns a basic condition of society and holds more than just the movement of people; a comprehensive approach is necessary in terms of sustainable urban planning and understanding. The **E5 model** of Van der Bijl and Van Oort was chosen to be adopted [105]. It has been developed in the Netherlands for assessing public transport projects, however, adapted by Fietscommunity in 2015 as a tool which makes it possible to analyse, develop and research the bicycle system in a uniform way. The model itself includes effective mobility (E1), efficient use of the city and/or space (E2), the economy (E3), the environment (E4) and equity (E5). The latter represent the five main domains in which mobility has an influence (and the other way around). A schematic representation is given in figure 2.1. Note that the combination of E1 and E2 is necessary to form networks and that both are connected to E3, E4 and E5, while E4 and E5 are the conditions for sustainability and inclusion.

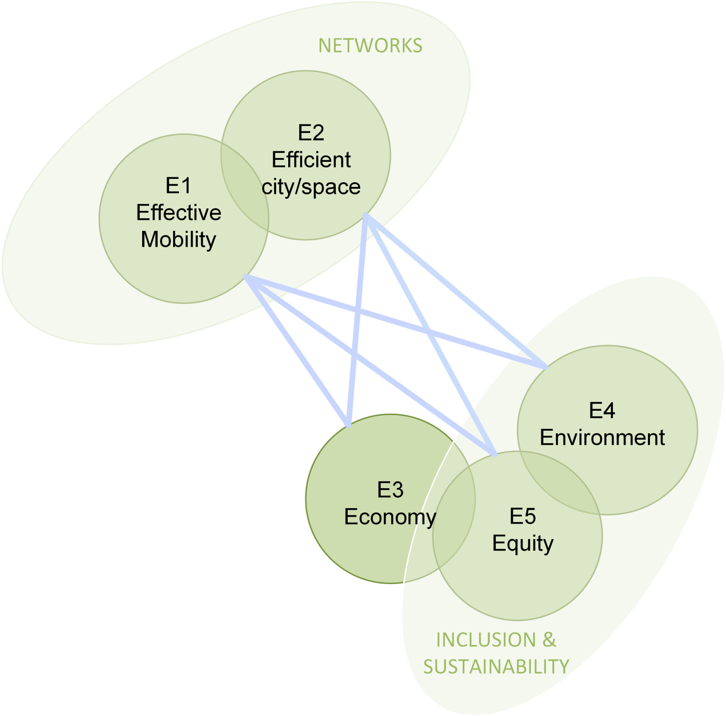


Figure 2.1: Extended E5 Model

This model is the result of the combination of different scientifically proven schemes and findings. The first one concerns the "Brever Law". In general, people are willing to spend about 70 to 90 minutes of their time on transport in one day. On the contrary to a lot of other parameters in the bicycle system, this time has proven to be a constant. The only exception to this rule concerns people in transport poverty; they will either spend a lot more time than 90 minutes or 0 minutes. The existence of a constant number like this directly implies the connectivity of mobility (E1) and efficient use of space (E2). Secondly, this can be linked to the 3P-principle (People, Prosperity, Planet) of John Elkington, stating that the three should be in balance in order to optimize each parameter. More importantly the adaption to his model: "success or failure on sustainability goals cannot be measured only in terms of profit and loss. It must also be measured in terms of the well-being of billions of people and the health of our planet ...", focuses on the equilibrium between different socio-cultural domains which coincide with the E5-model. All domains of this model have been further developed under the name of SUMP, Sustainable Urban Mobility Planning [114].

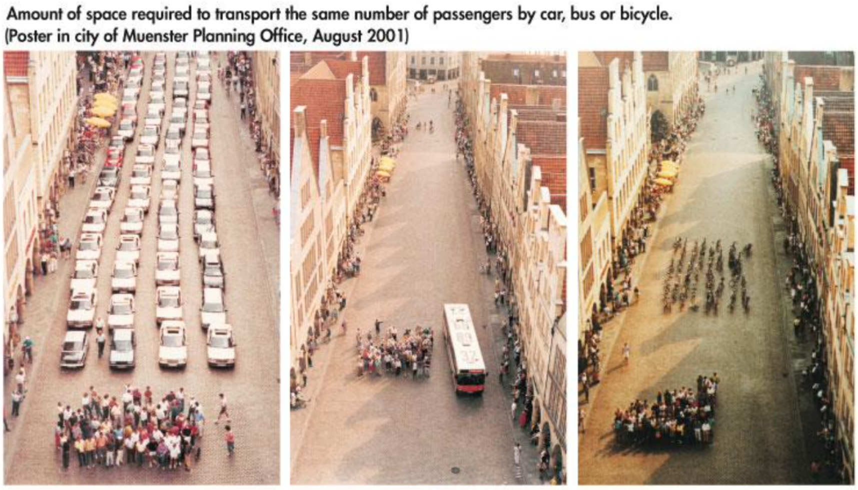
Furthermore, when looking into the bicycle system in this mobility framework, it is important to consider the needed **interaction between transport, usage and mobility** for a system to succeed. Further elaborated: the interaction between the means, modes, infrastructure, etc, either individual or collective (=transport), the interaction, conducting, operating, etc, by users of the system (=usage) and movements of persons and goods for certain reasons (=mobility) [106].

The latter model can be adapted and specified to cycling mobility according to table 2.1. When looking at the scheme, it is clear that the use -and thus the user- is crucial to connect the infrastructure and technology to its performance. This centrality implies that the user has to dispose over all means (financial, technical), skills (technical, social, language, orientation) and information as well as to acquire enough motivation and physical fitness in order to obtain an overall well functioning bicycle system. Note that also the context should be taken into account when examining the bicycle system: society, cultural assets, demography, topography, history, other available forms of mobility, etc.

Transport	Usage	Mobility
Infrastructure and Technology	**Use**	**Performance**
Modes	**Actors**	**Aims**
Materials and bike types Infrastructure (lanes, bridges, etc) Facilities (parking, maintenance, etc) Law and rules (standards, guidelines, etc)	Transport (commute, recreation, culture, etc) Maintenance, Enforcement Misuse, Crime etc	Accessibility, efficient transport Urban Quality, Economy Sustainability, social cohesion Safety and health

Table 2.1: Cycling inside mobility framework [106]

As has been mentioned in the introduction, public space in cities is scarce while the number of inhabitants keeps on increasing, resulting in an increasing demand of mobility. The space that is needed for this increase in mobility depends on the **dominant/preferred transport mode**. Figure 2.2 elaborates the latter for the same amount of people being transported by cars, bus and bicycles.



Amount of space required to transport the same number of passengers by car, bus or bicycle.
(Poster in city of Muenster Planning Office, August 2001)

Figure 2.2: Required public space: cars vs bus vs bicycles [106]

Although this photograph strongly seems in favour of bicycles when relating mobility to space, it is important to note that not all motorised rides can be exchanged by bike rides as the bicycle system is strongly subjected to its **limits**. The distance to be traveled in a city, its morphology and the need for individual versus collective mobility also have a significant impact in impose important limits on the bicycle system. Table 2.2 summarizes the findings of Van der Bijl and Wiersma concerning the preferred mode of transport in a certain type of city.

	Individual transport Local public transport	Collective transport Regional urban public transport
Concentration	Walking + cycling city	Transit city
Dispersion	Car city	Hybrid city

Table 2.2: Mobility versus space [106]

To conclude: space contains the mobility system -and thus the bicycle system- while the mobility system frames space.

2.1.2 Hardware, Orgware, Software

After establishing the relationship between mobility and space, the bicycle system itself will be examined. In this master's dissertation, a definition according to "Hardware, Software, Orgware" is adopted [96]. In this case 'Hardware' corresponds to physical elements, 'Software' to mental and virtual elements and 'Orgware' to the organisational and institutional elements. Different assessment tools exist in order to obtain a concrete insight in the system and different influential parameters. These will be discussed later. Table 2.3 represents an summarized overview of influencing parameters in the hard- soft- orgware definition from a collaboration between RVDB Urban Planning, GoDutchCycling and the Dutch Cycling Embassy.

Hardware	Network and Infrastructure Logistics Equipment Technology Cycling facilities Management and Maintenance
Software	Ideas and Proposals Policy and Programs Designs and Plans Budgets Projects and Events Promotion and Information Laws and Rules Guidelines and Standards Education and Research
Orgware	Co-operation and Organisation Administration and Registration Fora of Decision Making Financing and Funding Media

Table 2.3: Components of the bicycle system [96]

It is important to note that it is not always easy to distinguish org- and software in literature. Moreover, in terms of development and technology; hardware refers to the technology itself, software to the skills, knowledge and capacity that accompany the transfer of technology, orgware refers to the capacity building of the different institutional actors involved in the adaption process of new technology. In other words, the orgware makes the connection between the activity program (software) and the physical elements (hardware) of an area.

2.1.3 Definition

Next to the hard-, soft-, orgware system, general information; cycling data, usage, users, accessibility, experience, safety, the context; history, amenities, other available mobility services, and mapped or depicted data; maps, number of inhabitants, topography, climate and weather of a specific city or area are also key elements in order to generate a full overview of the bicycle system [106]. In other words, these components largely influence the effective establishment of a specific hardware, orgware, software bicycle system to a specific place.

To conclude, the bicycle system can finally be defined as the HSO-system combined with its context. Figure 2.3 visually represents the adapted definition.

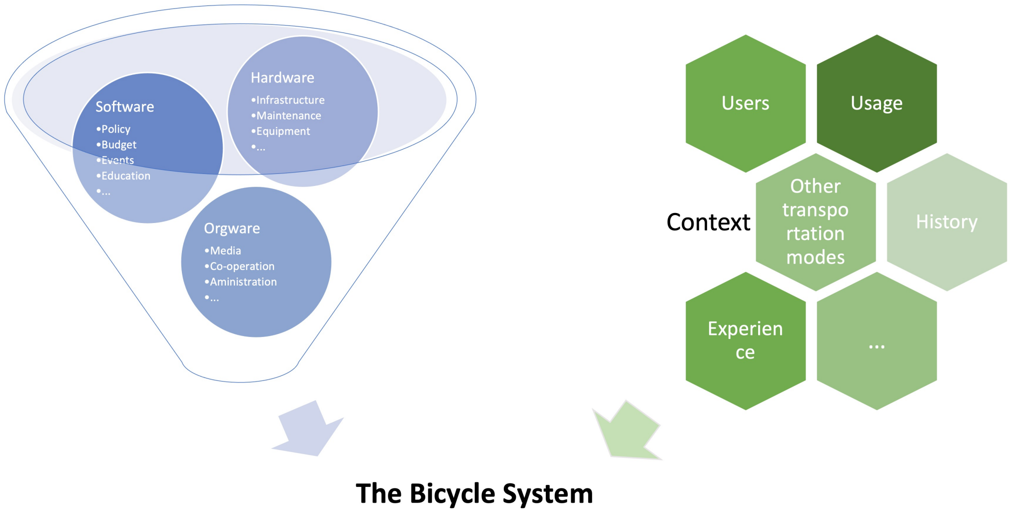


Figure 2.3: Definition of the Bicycle System

2.1.4 Cycling and its Benefits

It has been researched that the act of cycling has multiple beneficial effects, for both society and the individual: an increase of public health, a decrease of congestion, less air pollution, a greater sense of community, an increase in retail and manufacturing of bikes, an increase of tourism, an increase of social inclusion, etc. In the next paragraphs, these benefits will be specified according to the domains of the E5 model: effective mobility (E1), efficient city and/or space (E2), economy (E3), environment(E4), equity (E5) [106].

Efficient city and/or space
As mentioned in the introduction, more people will move to cities in the future. This means that more people will have to move around in cities with limited free public space. As a result, the capacity will be reached in terms of number of cars and car lanes. Although it would improve the environmental impacts, electric cars will not solve this issue of capacity and space. On the contrary, when car users would shift to the use of a bicycle, the transport capacity in the same typical urban lane could be increased to 14 000 cycles per hour, compared to 2000 cars per hour only [68]. As a consequence of this shift, the overall traffic will become more efficient, for car users, bicycles and public transport and less time would be lost due to congestion, meaning time will be saved.

Environment
The next topic that will be addressed concerns the environmental and climate benefits. Today, transport represents 16% of the world's CO_2 emissions. Transport by means of cars, SUV's and motorcycles represents 47% of the transport and thus 8% of the total emissions [48]. Although recent developments in electric vehicles are promising (both in technology and legislation), it is clear that a bicycle is still the more environmentally friendly option. Increasing the number of bike rides, would be an effective way to reduce the overall energy consumption and thus emissions. The latter has been recognised by the European Commission in their recommendation of 28/09/2021: "Energy Efficiency First: from principles to practice. Guidelines and examples for its implementation in decision-making in the energy sector and beyond." [18]. As smog and air pollution itself, are common barriers for people to use their bicycle in the city, better air quality could also increase mobility and health. Another direct result of this shift is the decline in need of energy resources [48].

Equity

Cycling has different social benefits. First of all, it is able to create a sense of community, even over different cultures. Secondly, it could also increase social inclusion and reduce transport poverty [107]. Lower costs compared to car ownership or (sometimes) public transport increase the overall mobility of people. The last important benefit that will be discussed concerns the increase in public health. The extra movement (and the possible reduction in air pollution) reduces chances of getting several illnesses and it could even improve productivity and happiness on the workfloor. According to a joint report by UN Environment-WHO-UNECE, ”Riding towards green economy: Cycling and green jobs”, an investment in cycling also creates new jobs [85]. More specifically they concluded an increase of cycling-related jobs, new types of jobs (e.g. in bike sharing), but also the fact that authorities play a major role in creating ”green cycling jobs”.

Effective mobility

Due to its congestion-easing effect and its accessibility cycling can contribute to a great amount in the creation of a global effective mobility system. This benefit also refers to the last-mile function that a bicycle fulfils in combination with other transport modes.

Economy

Cycling creates economic value due to all its associated benefits. The study of calculating the economic value of cycling to society is called: Bikenomics [11]. In order to obtain changes in policies or infrastructure worldwide, it is important to know the economic value of a specific system in a specific city. Several tools exist in order to obtain the correct economic value. An example of an assessment is the analysis performed by ECF in 2016 ”the EU cycling economy” [78]. By taking into account the previously mentioned general benefits as well as the direct economic benefits by investing in the bike industry and further specifying all the parameters by means of the Active Mobility Agenda (Figure 2.4), they made up a sum of 513.19 billion euros linked to the level of cycling in the EU-28 in 2016. A full overview of all parameters can be found in table 2.4.

Figure 2.4: ECF Active Mobility Agenda [78]

The results clearly show that the economic value of cycling, not just to oneself, but to society is huge and that the benefit to defining and establishing a refined bicycle system, next to public transport and individual motorised transport is high. It has to be noted that the calculation method and used data still need to be improved as several quantities have been estimated and as some costs and benefits have not yet been taken into account or were hard to quantify. Nevertheless, this early stage assessment indicates that cycling has economic value. Figure 2.5 shows the relative economic importance of the different areas.

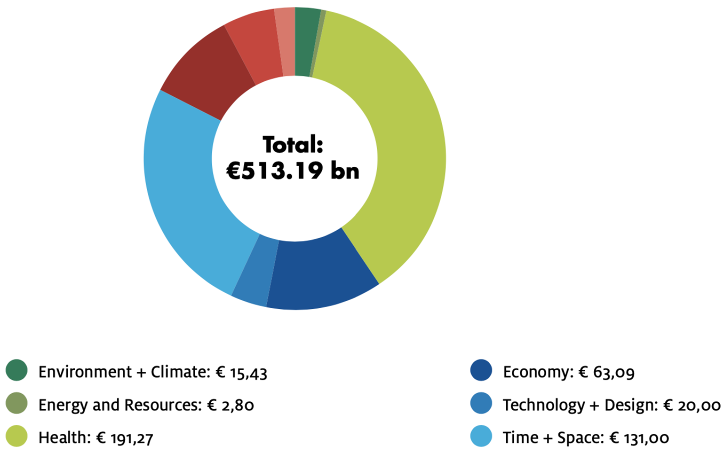


Figure 2.5: EU Benefits of Cycling: Summary [billion euros] [78]

The conclusion that can be drawn from the broad variety of benefits in the different areas is the following: there is a need for more integrated cycling solutions and the definitions of good systems. Furthermore, the importance of Bikenomics cannot be underestimated concerning cycling advocacy and how it can help to make cycling politically mature in different parts of the world.

Lastly, it is important to note that all bicycle systems in different countries over Europe have different characteristics that influence its parameters as well as its potential. Some examples are the percentage of daily trips that are made by bicycle, the distance traveled, the purpose of riding the bicycle, which population group cycles, how many people own a bicycle, how many of the daily trips that can be switched to a bike ride etc [78].

Climate	Reduced CO2 emissions
	Related benefits to reduced CO2 emissions
Environment	Reduced air pollution
	Reduced noise pollution
Environmental asset development	Less sealed soils
	Less soil pollution
	Better water quality
Energy	Fuel savings
	AM hybrid contributions to E-mobility
Resources	Resource savings in vehicle production + infrastructure building
Direct health benefits	Longer lives
	Healthier lives
	Improved mental health
	Improved kids health versus sedentary life styles
Road safety benefits/reduced accidents	Reduced fatalities
	Reduced serious injuries
	Reduced light injuries
Health economic benefits	Reduced absenteeism
EU bike industry	Value of EU bike manufacturing
	Value of EU parts/accessories manufacturing
Bicycle and parts sales and repairs	Value of bike sales
	Value of parts/accessories sales
	Value of bicycle repair
Bicycle tourism	... from other businesses
Road safety	Reduced material damage
Urban Design	Urban design-benefits of ITS in urban planning+ infrastructure
Smarter cycling	Contributions to new technolog + smart cities development
Quality of time spent cycling	
Shopping by bike	
Child welfare	Time savings for parents
Quality of space	Space savings bike : car 1:10 parking - 1:>5 moving
Social affairs	Social equality
	Gender equality
	Child welfare
	Social safety
Mobility/Transport	Congestion-easing
Road Infrastructure	Construction
	Maintenance
	Subsidies for public transport
	Inter- and multimodality
	Transport taxes and tax subsidies
Diversity of (cycling)-cultures	Resilience + robustness
	Cultural connectivity
	Accessibility

2.2 Evolution in Europe

2.2.1 History of the Bicycle System

The current state of access to cycling, its perception and its popularity are different around all cities in the world. Currently, The Netherlands are being considered as pioneers. The country counts more bikes than people and it is one of the safest places to cycle in the world. What is important to note, is that it has not always been this way. A long evolution has happened and different factors contributed to a bigger focus on cycling inclusive mobility planning. In this section, an brief overview of the history of cycling and its perception in Europe, starting from the 19th century, is given.

The main references that have been used in this paragraph consist of the research of Ruth Oldenziel, a Dutch professor with numerous scientific publications in different fields including history, science and technology, American and European History, mobility studies, cultural studies, and gender studies. More specifically the books "Cycling Cities: The European Experience: Hundred Years of Policy and Practice" [82], "Cycling and Recycling: Histories of Sustainable Practices, volume 7" [83] and "Being Modern: The Impact of Science on Culture in the Early Twentieth Century" [80] have been used. Furthermore, also the research of Henk-Jan Dekker was included 'Cycling Pathways: The Politics and Governance of Dutch Cycling Infrastructure, 1920-2020' [28]. Finally, research of the BBC will be used 'Cycling across Europe in the pandemic' [99].

Figure 2.6 gives a schematic representation of the perception of cycling over time. A more detailed description is given below.

Traditional bicycles have been used since the 19th century. Nevertheless, in the mean time, bicycles and cycling behaviour have undergone several transformations due to different purposes of use, technological developments -in both bikes and other transport modes- and the perception of the bicycle versus motorised vehicles or walking. This section is dedicated to give an overview of this historic process of cycling in Europe, starting from 1860.

In the 1860's bicycles were macho machines ridden by young men who cherished the sense of danger and of freedom that they evoked. This was caused by the introduction of professional racing, which was sponsored by manufacturers to boost sales and sensation. The races were targeted to lower-class young men, who saw the opportunity to earn prize money with it. As a result, the early 'cycling machines' had become a symbol of irresponsible male modernity and a lot of accidents and deaths followed.

Starting from 1880 to 1900, the meaning and design of bicycles went trough a process of differentiation. More safety was demanded by older men, urban couples, single middle class women and the upper class. These new target groups were rather fascinated by bicycle touring than by racing. It once again lead to an increase in general sales. Furthermore, this innovation had been picked up by the United States. As a result, the bicycle became an industrially mass-produced innovation, which finally caused the bicycle to lose its avant-garde character. Bicycles became the vehicles of exploration that paved the way for individual, middle-class mobility. All over Europe, thousands of enthusiasts celebrated the sense of freedom that cycling gave them. Traditionally. individual mobility was a class-bound activity. Ordinary people walked; the aristocracy rode horses. Cycling provided people with a cheap and reliable alternative. During this period, the iconic literary expression 'iron horses' referred to bicycles instead of the steam locomotive.

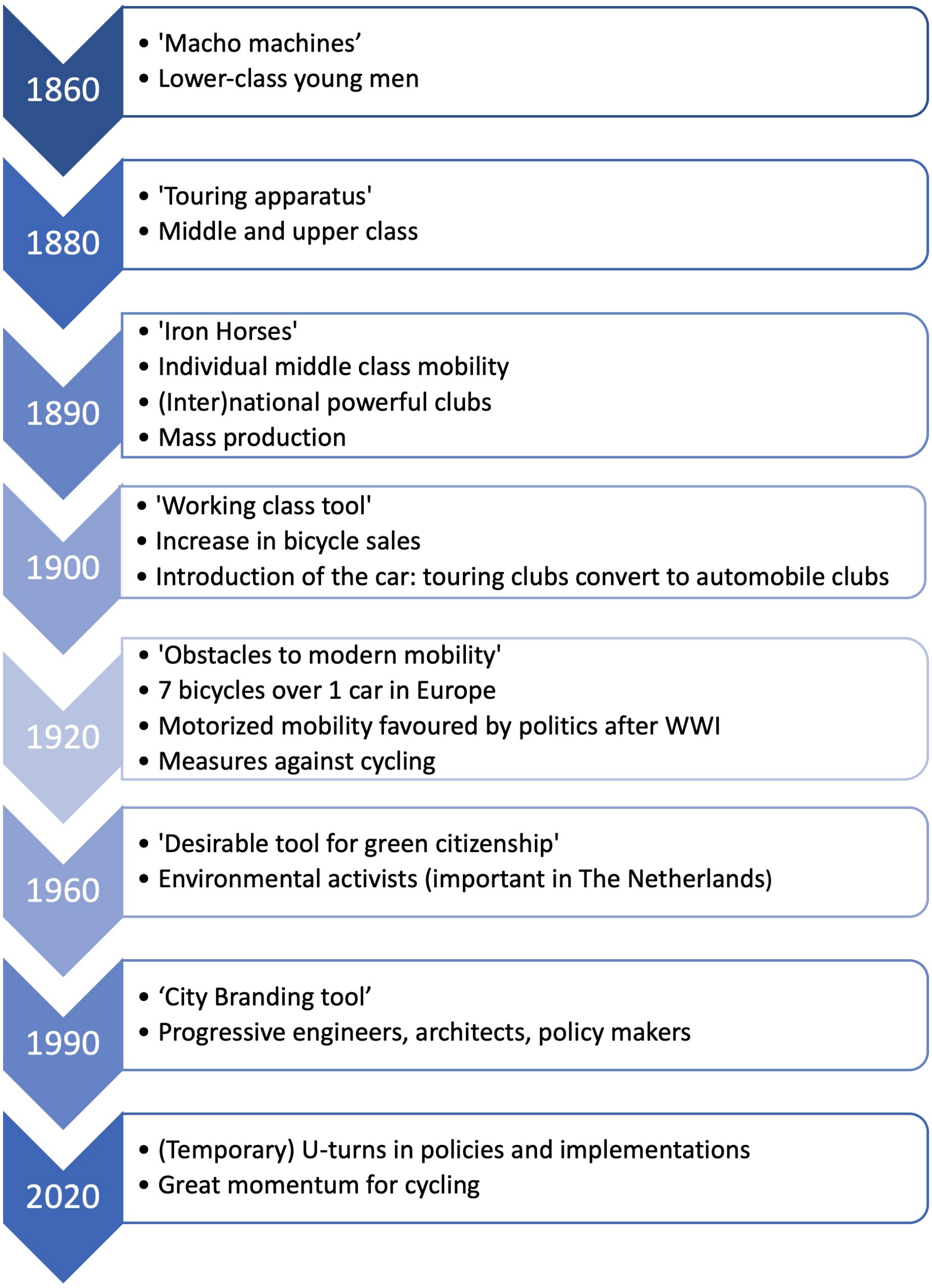


Figure 2.6: Timeline: the perception of cycling in Europe

In order to promote their interests, cyclists established powerful clubs and associations, both nationally and internationally. The touring clubs provided a system of bicycle support services, guidelines, maps, hotels, railroads and signs. Furthermore, the clubs created a transnational and European feeling of collaboration, generating a tourist infrastructure and a touring experience. Forming a pioneering user movement, cyclists were more successful in lobbying municipal, local, national, and foreign governments for better roads and services and pressuring manufacturers for better designs. Local circumstances dictated different lobbying efforts (e.g. the Belgian cobble stones compared to the Dutch brick roads). Exactly this infrastructure would be the one that automobile lovers and their organisations would later on expand and perfect. As Ruth Oldenziel stated: ”Streets were not build for cars.”.

These clubs of middle-class bicyclists, all over Europe finally helped shape Europe in important ways. Some examples are the establishment of a system of representatives, pioneering the traffic-sign convention and cooperating across borders. In order to address this explosive growth in cross-border bicycle traffic, the LIAT was launched (Ligue Internationale des Associations Touristes), bilateral agreements were signed in order for members of one organisation to fully be able to access to the services of collegial ones. In this way, the national cycling organisations played a key role in forging a middle-class culture of governance and leisure. The bicycle touring also contributed to the fact that trains and bicycles became mutually supporting technologies. For example, in 1984, American railroads carried more than 430000 bicycles to places where riders could start there tours.

Nevertheless, in the same moment of time, resistance to cycling came from anti-modernists e.g. the Church, farmers, cultural conservatives as well as some aristocrats. On top of this, as was mentioned before, the American mass production of bicycles let to the loss of the avant-garde character of the machine. This 'Velomania' finally led to overproduction and the collapse of the market in the United States. As a result, companies entered the automobile market. Cars took over as 'the Next Big Thing' and took the image of modernity with it. Nevertheless, the end of media coverage did not imply the end of users' interest. The new user group came from a lower social class and was followed by a change in user activism.

After the Paris exhibition of 1900 -which is often seen as a symbolising moment of automobiles entering the 20th century as the trailblazers of individual mobility and technological modernity- the touring bicycle became a work tool, 'a horse of the poor'. Professionals, shopkeepers and civil servants began to use bicycles for daily use: to conduct business, to commute and to transport goods. This evolution was followed by an change in bicycle manufacturing: brakes were improved, racks and sturdy stands were added. Next, the industry brought down their prices still further in the 1920's. During the same period, car sales increased dramatically (but still remained small in absolute terms). Because of the affordability, more and more people were in the possession of a bicycle. As an example, already in 1927, one third of the Dutch residents owned a bicycle, in Sweden it was every fourth, in Denmark, Switzerland and Belgium every fifth, Germany and France, every sixth, Britain every seventh and Italy every thirteenth. The only exception in that time period was the United States. In the 1930's, there were seventeen cars to every bicycle, where in urban Europe, there were seven bicycles to one car.

As can be seen on figure 2.7, until well into the 1960's, bicycles remained the most popular means of transport. Bikes outpaced public transit and cars, for most people, it still offered 'the modern alternative' for walking and public transit.

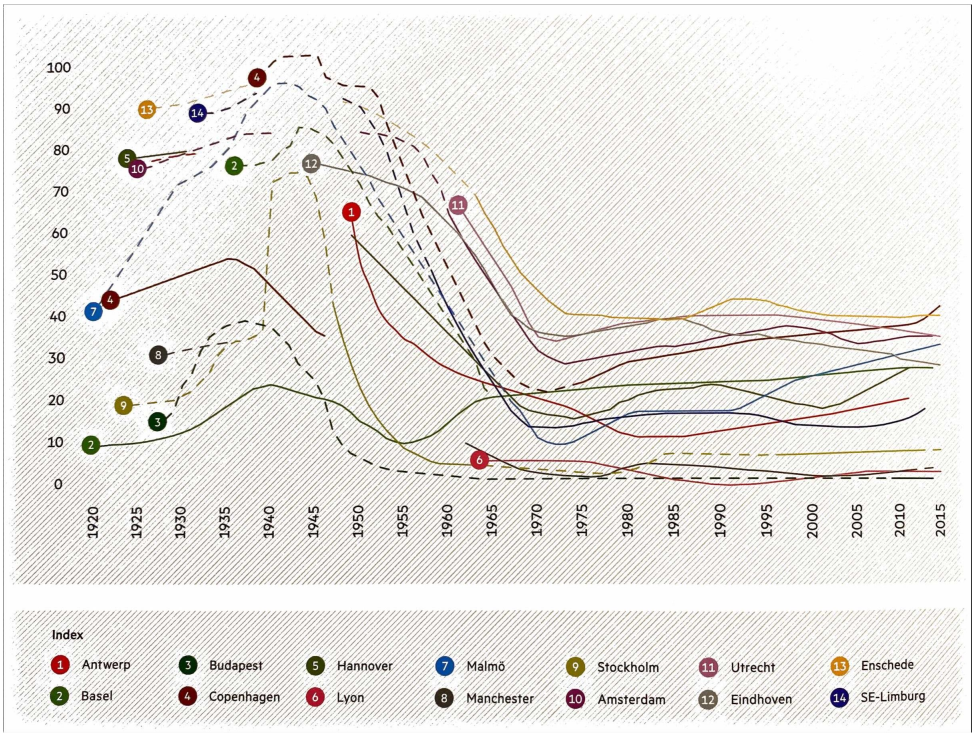


Figure 2.7: The bicycle as main transport mode [82]

After 1900, many national touring organisations, dominated by bourgeois, either renamed themselves automobile clubs or simply began to redirect their focus away from cycling. Other national cycling clubs collapsed. At first, LIAT worked together with AIACR (Association Internationale des Automobile-Club Reconnus) in order to improve roads and to ease cross border traffic flows pioneered by LIAT for bicycles. Later on, AIACR totally excluded the interests of horse-and-buggy drivers and cyclists. Similarly, European city governments began to treat bicycle traffic as a problem to be solved rather than as a solution to be embraced. More roads were constructed exclusively for cars (e.g. the introduction of Autobahnen) and cyclists were being blamed for an increase in accidents and deaths on the road. Nevertheless, some clubs, like the Dutch national tourist organisation did advocate and finance separate cycle paths along rural roads for touring.

After the First World War, states and local authorities themselves, took a more active part in transport, urban development and social planning. While doing this, motorised mobility was strongly favored. The idea that motorised traffic, would, in the long run, substitute what they cast as the old-fashioned bicycle dominated. As a result, their vision was supported by how traffic would develop rather than what they actually observed in the streets: bicycles. They believed that the future belonged to the United States and thus to the car. Furthermore, it is important to note that the level of auto-mobility in different geographical places, does not account for the anti-bicycle policies. This can be proven on the one hand by the relatively late motorisation of Italy and Germany and their policies that control cyclists. On the other hand, in the Netherlands, the automobile also arrived late, but here, the tourist organisations supported a classless image of cycling, whereas policymakers tended to regard bicycles, and legislated accordingly. This vision resulted in Amsterdam becoming the mecca of urban planning at the time. Its plans were presented as a prototype for international development by Van Eesteren and Le Corbusier and the bicycle plan was incorporated in his plan for the future: 'The Amsterdam Blueprint'. Among others, one of the findings of this model held that urban expansion should not go beyond 30 minutes of bike commuting. The blueprint served as an inspiration to a number of cities in Europe, the United States and the colonies. Nevertheless, the bicycle-related component of the Amsterdam blueprint was abandoned and not followed by planners in the other cities. In Denmark, the automobility arrived early and expanded quickly, yet policymakers also assigned equal traffic rights to cyclists and motorists. What was shared over European Nations was a vision of future cities. This vision was dominated by motorist lobby groups, new engineering professionals and policy makers. As cyclists were still seen as obstacles to more modern modes of mobility and the cause of the alarming growth of lethal accidents, new measures were taken to single out cyclists. Cyclists were for example re-educated and disciplined in Belgium and Germany and a bicycle tax was even introduced in the Netherlands. The latter with the aim of subsidizing motorways and separate smaller cycle lanes to enlarge the room for motorists.

The same trend continued for the years to follow. As the general welfare in Europe increased after the second World War, more people could afford a car - the symbol of modernity. This way, the bicycle disappeared further into the background of urban planning and daily life.

However, lead by environmental activists in the 1960's and early 1970's, the bicycle revived. In response to 'green tech' solutions, older technologies were mobilised as political tools to save the planet. For example, cargo bikes were appropriated as an alternative to automobiles. As a result of this movement, cycling activists were able to change the image of the bicycle from a working-class vehicle to a desirable tool for green citizenship. Cycling regained a fighting chance for equal traffic among motorised traffic. Consequently, the car-based urban vision was being questioned by progressive architects, engineers etc. As can be seen on figure 2.7 cycling stabilised and grew later on because of this effect in between 1975-1995.

Since 1990's, urban cycling has acquired policy standing as an indicator of public health, sustainability and growth. Furthermore, it evolved in becoming a tool for city branding rather than a symbol of modernity. Nevertheless, not only the image of the bicycle system shaped the current bicycle system. Eventually, traffic engineering idea's and the layouts of cities did so. This clarifies the huge differences that are being perceived in Europe. Note that from 1995 until now the trendline of figure 2.7 is slightly increasing again.

This difference, and especially the thriving of The Netherlands in the field of cycling, was researched by Henk-Jan Dekker [28] at the University of Eindhoven. He stated that the current success of the bicycle is mainly due to the fact that the booming of mopeds around 1950, resulted in designing more cycleways. The latter because mopeds were assigned to cycleways. For safety considerations, the cycleways were developed separately from motorised traffic and they were designed with a sufficient width. Nevertheless, they did not only favour mopeds, but also cyclists due to which a consistent amount was maintained during 'the great cycling depression'. In the 1970's this rather dangerous shared space lead to the activism which eventually regained the place of cyclists in urban environments. In other countries, the cycleways had not been separated from the beginning or at least not to the same extent. Consequently, due to the increasing amount of motorised traffic, it simply became too dangerous to ride a bicycle.

The last moment of significant historical developments that will be discussed, is the influence of the Covid-19 crisis over the development of several bicycle systems in Europe [99]. In general, the pandemic has allowed politicians to make a U-turn in their policies. One of the most important reasons for this, lies in the absence of cars in urban environments due to the safety restrictions. Due to the same limitations, people started to perform more sports and increased their time spend to leisure - and thus also to cycling. Furthermore, the bicycle became one of the safest modes of transport. In Belgium for example, this resulted in a big increase in sales of e-bikes and long waiting lists. In Paris, France, huge investments were made in cycling. Several streets had been completely blocked for cars and bicycles were welcomed. The actions clearly resulted in the aimed effect, as the amount of cyclists rapidly increased. Several other examples can be made.

Nevertheless, it should be noted that not all of these interventions were permanently implemented. But, it can be concluded that the momentum of great attention towards cycling had a general positive influence and has created incentive.

Finally, one can conclude that in today's post-industrial cities, the bicycle is back on the political and cultural agenda as the vehicle of lifestyle choice, suggesting again a forward-looking - and sustainable- future (European Commission, United Nations, urban planning departments over Europe, etc). Furthermore, an increasing number of studies on cycling and the history of cycling are being delivered. The field is thriving. The bicycle, once a marker of poverty, is now an indicator for liveable cities.

2.2.2 Current Guidelines

Important institutions like the European Commission or the United Nations are invoking new recommendations to enhance the popularity of the bicycle system, provide guidance on urban planning and the understanding of cyclists and the bicycle system in general. This section will focus on two of the most influential publications in Europe related to urban planning and cycling. These policies have been adapted and specified in different places and lie at the basis of the urban planning methods and perception of the cyclist cities of today. More specifically, Sustainable Urban Mobility Planning (SUMP) [114] and Promoting Cycling for Everyone as a Daily Transport Mode (PRESTO) [30] will be discussed. Both documents have been published by the European Union.

Before deep diving into these policies, some general guidelines related to the design of cycleways will be discussed. This general introduction to spatial design and planning is mainly based on the Mobile 2020 handbook on cycling inclusive planning and promotion [27] funded by the intelligent Energy Europe program of the European union and the Belgian design guidelines.

2.2.2.1 General Design Considerations

In order to create a cycling inclusive environment, it is necessary and generally accepted to adopt the five Dutch design principles when designing bicycle infrastructure.

1. Coherence: infrastructure should connect starting and ending points of the users of the bicycle system.
2. Directness: infrastructure should be able to provide the shortest routes.
3. Attractiveness: cycling should be a pleasant experience.
4. Safety: cycling infrastructure should be designed in a way that provides safety for all users of the public road (not just cyclists).
5. Comfort: cycling should be a fast and comfortable experience.

The first two design principles can be obtained by a consistent and strategic form of mobility planning. The section about SUMP will give further guidance on this topic. The last three principles depend on a broad range of different design variables; type of pavement, lightning (e.g. tunnel), cycling bridges, slopes, drainage, tidiness, sharpess of a bend, obstacles, connection to public transport, etc...

In what follows, some general indications, guidelines and points of attention will be addressed regarding the design of bicycle infrastructure. More specifically considerations regarding the standard width, speed, cyclists, the network design, type of routes and signalization are highlighted.

Standard Width and Speed
Concerning the standard with of a cyclist including the necessary free space, most European guidelines suggest a width of 1m to 1.5 m. This holds when traditional bicycles are considered. Nevertheless, in the mean time, bicycles and cycling behaviour have undergone several transformations due to different purposes of use, technological developments and the perception of the bicycle versus motorised vehicles or walking. Table 2.5 gives an overview of the most common types of bikes and there sizes.

	Length [cm]	Width [cm]	Height [cm]	Eye height [cm]
Traditional bike	165-180	40-75	90-110	140-185
Children bicycle	100-150	40-50	60-90	90-140
Tandem	275	40-75	90-110	140-185
Tricycle	165-180	80	90-11	140-185
Recumbent bike	165-200	40-75	110-130	110-130
Hand bicycle	165-180	80	80-100	110-130
Bicycle with child trailer	300	80	90-110	140-185
Bicycle with child seat	165-180	40-75	120-140	140-185
Cargo bike	200-320	60-120	90-110	140-185

Table 2.5: Typical dimensions of most common bikes

Looking at this table, one can conclude that sizes of typical bicycles and their corresponding eye height have big ranges, as can be seen below.

- Length: 100 ⟶ 320cm
- Width: 40 ⟶ 120cm
- Height: 60 ⟶ 140cm
- Eye height: 90 ⟶ 185cm

This phenomenon results in a need for flexibility concerning design requirements of cycleways in order to maintain safe and comfortable conditions for all users.

Furthermore, the recent introduction and booming of the e-bike cannot be ignored as cycleways should be designed or adapted accordingly taking into account the speed differences. An ebike reaches 20km/h on average compared to 15km/h for a traditional bike. Likewise the shift in dimensions, this change in speed causes a need for flexibility and adaptions in the existing cycling network. Hindrance should be avoided by foreseeing space for cyclists to overpass each other and by designing bends that are large enough.

Network Design

In terms of network design, attention should be payed to the different attraction poles when taking into account origins and destinations. These preferential, theoretical routes should then be transformed into real routes. Furthermore, when designing cycleways, one should be aware of the different levels of routes and thus functions: connecting, distributing or accessing (defined according to the Mobile 2020 handbook [27]).

- Main routes have a connecting function at city or intercity level. They connect suburbs and residential areas to the city centres but also villages, towns and cities with each other, outside the built- up area.
- Top local routes have a distributor function at the district level of the built-up area. They provide the main cycling connections between urban districts and major urban areas.
- Local routes have an access function at the neighbourhood level. They include basically every street or track that can be used by cyclists, connecting all buildings and other origins and destinations to higher level routes.

Once cycling networks have been established taking into account these guidelines, crosslinks between different networks as well as connections to other modes of transport and integration with public transport should be foreseen.

Type of Routes
Different solutions exist for introducing cycleways. In order to do so, the two main criteria that are taken into account are the traffic intensity and the maximum speed for motorised traffic. [25] It is clear that the higher the traffic intensity and the maximum speed, the higher the necessary safety measures for cycling. A distinction can be made between:

- Road space sharing: all road users share the same space, mostly used in $30km/h$ zones or residential traffic areas
- Cycleways adjacent to the motorised traffic: a visual distinction between the 2 road types and users in order to emphasize the observation between motorised and cyclists and thus the safety, mostly used on roads with $50km/h$ speed limits.
- Separate infrastructure: high traffic intensity and speeds ask for physical separate infrastructure.

Finally, also traffic signs and regulations hold an important role in the enrolment of a bicycle system. Its most important function is to help cyclists unfamiliar with the local area to find their destination.

Note that these recommendations are not meant as strict rules as the local context always needs to be taken into account. Nevertheless, it is useful to keep them in mind as recommended quality standards.

2.2.2.2 Presto - Promoting Cycling for Everyone as a Daily Transport Mode

Promoting Cycling for Everyone as a Daily Transport Mode, PRESTO, is a project of the EU's Intelligent Energy Agency from 2010 [30]. The fact sheets and guidelines of PRESTO were the first effort to bundle state-of-the-art European knowledge and experience on urban cycling policy in an easy and accessible format. The document concerns a general framework, outlining the fundamentals of an integrated cycling policy as well as a first division of 'starter', 'climber' and 'champion' cycling cities. The latter being a distinction between cities according to their current level of cycling development. These definitions are commonly used and spread in bicycle-related literature.

In general, the distinction is based on two indicators: cycling conditions and the cycling rate.

- Cycling conditions assessment: how safe, easy, convenient and attractive cycling is today.
- Cycling rate measurements: the share of daily trips that is made by bicycle, defined by on-street counting or surveys.

Broadly speaking, the cycling rate rises as cycling conditions improve. This statement also works the other way around: as more people cycle, they will demand better conditions, resulting in better conditions. Based on these findings, the distinction between starters, climbers and champion cycling cities is made, see figure 2.8.

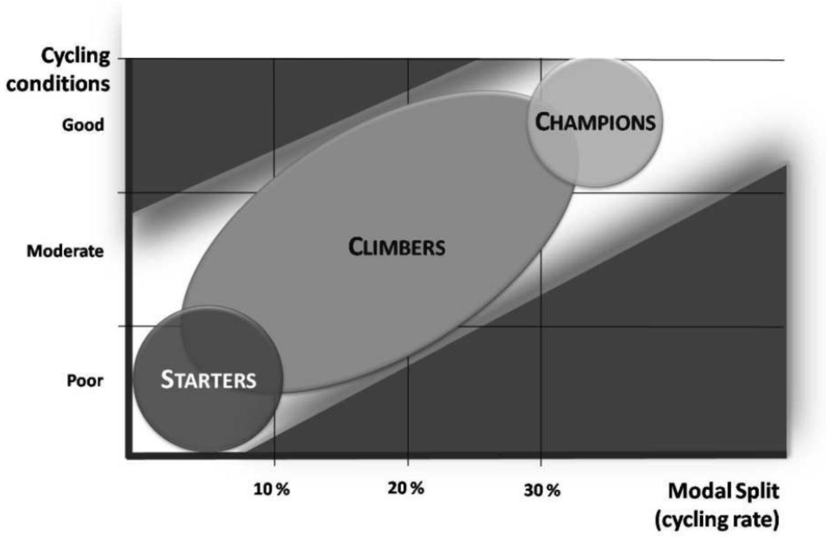


Figure 2.8: Starter, climber, champion cycling cities according to PRESTO [30]

Depending on the stage of a specific cycling city, different theoretical strategy efforts have to be made as different challenges are faced. Figure 2.9 represents the efforts that are suggested using this scheme. It clarifies that each level has different goals; from making cycling possible, safe and respectable to getting people on a bicycle and finally keeping people on a bicycle. A a result, these needs require a specific policy mix of infrastructure and promotion efforts.

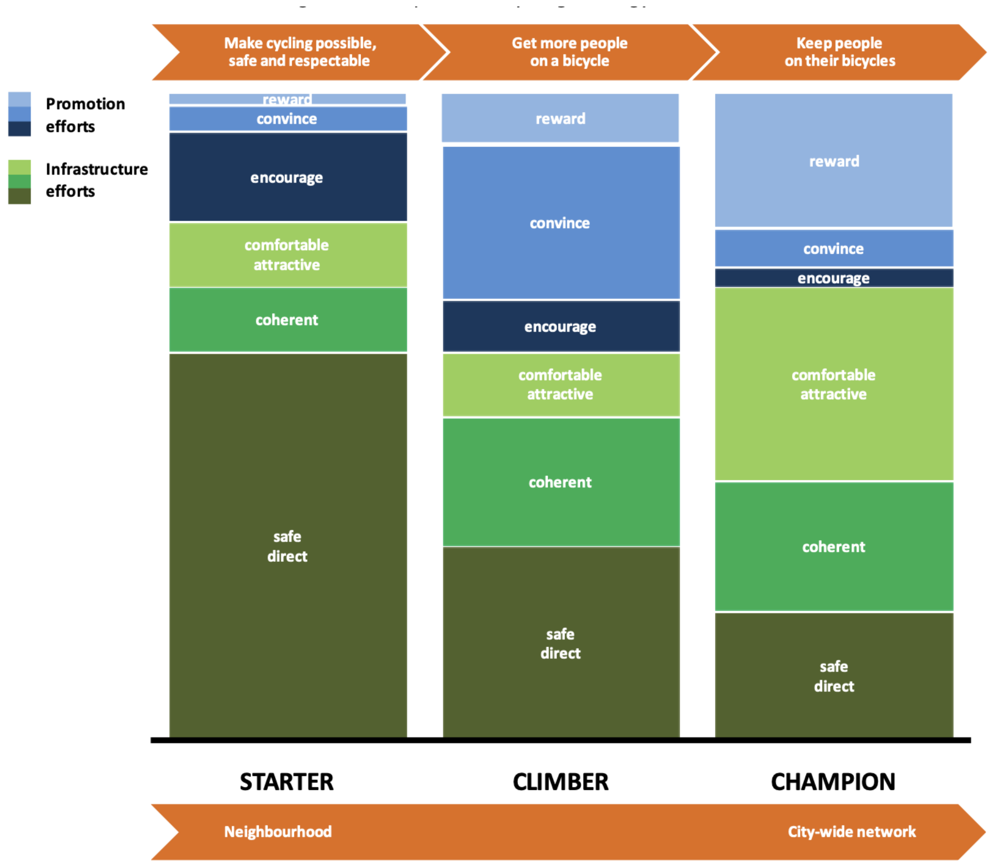


Figure 2.9: Sequence of cycling strategy efforts [30]

Concerning infrastructure efforts, it is suggested to focus on the five Dutch design principles: safety, directness, coherence, comfort and attractiveness. More specifically, concerning starter cycle cities: it is suggested to make a selection of high-potential neighbourhoods and start by making these cycle-friendly instead of enrolling a plan over the whole city. Climber cities should, in general, focus on generating a more cohesive network, high-quality and high-profile links, storage facilities etc. Lastly, champion cities should focus on efforts that enlarge the quality of the system, making it more comfortable and attractive, e.g, maintenance and improving flow and speed.

Promotion efforts also differ depending on the current development stage. It is suggested that starters, climbers and champions should respectively focus on convincing those who just need a slight push to start cycling or cycle more, on convincing those who still hesitate and/or creating positive associations for cycling and finally to continuously reward and support cyclists.

2.2.2.3 Sump - Sustainable Urban Mobility Planning

The introduction of SUMP or Sustainable Urban Mobility Planning by the European Union in 2013 has totally shifted the approach on mobility planning by introducing a different perspective as a new standard. This innovative sustainable planning, was followed by a large renewed interest in cycling in Europe. The main objectives of the theory include [114]:

- Ensure all citizens are offered transport options that enable access to key destinations and services;
- Improve safety and security;
- Reduce air and noise pollution, greenhouse gas emissions and energy consumption;
- Improve the efficiency and cost-effectiveness of the transport of persons and goods;
- Contribute to enhancing the attractiveness and quality of the urban environment and urban design for the benefits of citizens, the economy and society as a whole.

An overview of the philosophy, points of action and aim of the theory in comparison with traditional transport planning is given in table 2.6. Note that the E5 elements are clearly recognizable in this table: Effective mobility, Efficient use of the city and/or space, Economy, the Environment and Equity. On top of this, the theory aims at including and integrating all forms of transport: public and private, passenger and freight, motorised and non-motorised, moving and parking.

Traditional Transport Planning		**Sustainable Urban Mobility Planning**
Focus on traffic	⟶	Focus on people
Primary objectives: Traffic flow capacity and speed	⟶	Primary objectives: Accessibility and quality of life as well as sustainability,economic viability, social equity, health and environmental quality
Modal-focused	⟶	Balanced development of all relevant transport modes and shift towards cleaner and more sustainable transport modes
Infrastructure focus	⟶	Integrated set of actions to achieve cost-effective solutions
Sectorial planning document	⟶	Sectorial planning document that is consistent and complementary to related policy areas such as land use and spatial planning; social services; health; enforcement and policing; etc.
Short- and medium-term delivery plan	⟶	Short- and medium-term delivery plan embedded in a long-term vision and strategy
Related to an administrative area	⟶	Related to a functioning area based on travel-to-work patterns
Domain of traffic engineers	⟶	Interdisciplinary planning teams
Planning by experts	⟶	Planning with the involvement of stakeholders using a transparent and participatory approach
Limited impact assessment	⟶	Regular monitoring and evaluation of impacts to inform a structured learning and improvement process

Table 2.6: Principles SUMP

Further conditions contributing to a successful SUMP include; horizontal and vertical integration, the generation of a long-term strategy and finally the generation of a self-assessment tool of current and future performances [14]. The general conclusion is that sustainable urban mobility planning requires a good preparation, rational and transparent goal setting and a careful elaboration and implementation of the plan (the planning cycle).

In 2019, the European Union released ”Supporting and Encouraging Cycling in Sustainable Urban Mobility Planning” [67], in which an elaboration is given on how to support cycling at the local level. The planning cycle of the original SUMP is adapted to this specific case.

More specifically, the potential for more cycling in the future according to this recommendation lies in including the following aspects in the planning cycle for the long run:

- The ’interested but concerned’ target group. According to Roger Geller in Portland, USA, this group corresponds to 60% of the world population.
- Substituting short-and medium distance car trips by bicycle rides (less than 5km).
- Stimulate the use of cargo bikes for deliveries.
- The growing trend in e-bikes (largely at the expense of conventional bike sales), because: they make it easier to travel longer distances (up to 7km vs 5km for traditional bikes), to transport greater loads, to overcome natural obstacles such as inclines and headwinds, offering an alternative to company cars and lastly being ideal for recreational activities.
- The potential of bike-sharing (free-floating vs docking stations, electric vs traditional vs cargo).

- Cycling for recreational and tourism purposes enjoys growing popularity across the continent (e.g. Eurovelo network).

It is important to note that these potentials for more cycling imply the need for evolving infrastructure. The provision of cycle highways and wider paths are needed for respectively the e-bikes and cargo-bikes (or other non standard bicycles). Signposting, sufficient parking facilities, an appropriate design according to the stress level of cyclists ('interested but concerned', 'enthused and confident', 'strong and fearless') should be included, e.g. adapting the width of cycle-ways or separating them from motorised transport. In urban context, these changes should come at the expense of infrastructure for individual motorised transport and should not cause any conflicts with pedestrians. Lastly, multi-/inter-modality should be enhanced. To conclude, the five Dutch design core principles are given to provide a valuable network of cycle routes (rather than just introducing a grand city-wide master plan of wide cycle tracks separated from traffic).

Furthermore, some suggestions are given concerning the organisational aspect. The first one being that a vision for cycling should be a part of a wider mobility vision as promoting cycling is as much about promoting cycle use as it is about managing car use (e.g. the circulation plan of the city of Ghent introducing filtered permeability for cars). Secondly, it emphasizes the need of cross departmental coordination (across different political disciplines) and coordination with stakeholders (businesses, users, police, public transport, etc). Furthermore, it is stated that a assigning a full-time cycling officer could really enhance this latter aspect. Lastly, a sustained level of investments in cycling infrastructure is essential.

Finally, it is emphasized that awareness-raising campaigns and the training and education of cyclists (cycling to school and work) are essential, also safety (feeling) can be increased by proper law enforcement. Even though SUMP focuses on urban strategies, the national and European support level should not be ignored.

2.2.3 Contemporary Developments and Challenges

As has been established, the current mindset and components concerning the bicycle system are owned to several years of development and investments into the system. A lot of actors are still driving change and innovation in this system as a whole.

When taking into account the quadruple helix innovation model, different stakeholders can more easily be identified and their interactions in the knowledge economy can be understood. In general, four actors can be defined: the academic world, the industry, governments and institutions and civil society. The model emphasizes the co-evolution of know-how and knowledge creation between the different actors and takes into account the media- and culture-based public. What results is an emerging fractal knowledge and innovation ecosystem, well-configured for the knowledge economy and society. [13]

As a result, this model can be used to understand the developments in the bicycle system. Figure 2.10 is a visual representation of the general model.

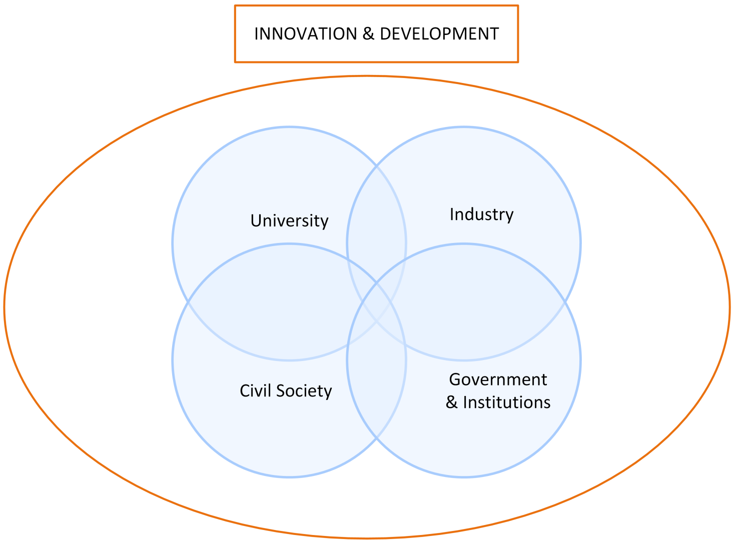


Figure 2.10: Quadruple helix: general framework

A list of involved stakeholders when looking at the bicycle system is given below.

- University: Traffic experts, social scientists, engineers, etc.
  e.g. Serge Hoogendoorn, Dick Ettema, Ruth Oldenziel
- Civil society: Activist groups, respondants of questionnaires, etc.
  e.g. ECF, DCE, Fietsberaad
- Industry: bike industry, consultancy companies, etc.
  e.g. Van Moof, Copenhagenize
- Government and institutions
  e.g. Belgian Government, European Union, European Commission

All these groups of people either drive developments concerning the bicycle system or react to them. Some of the most important evolutions that are happening at this point include: technological developments in bicycles and other (active) transport modes, behavioural changes, a need/interest for the integration of different modes of transport due to a lack of space and the distribution of space. Note that this is not an exclusive list of current challenges.

2.2.3.1 Technological Developments Vehicles

Traditional bicycles have been used since the 19th century. Nevertheless, in the mean time, bicycles and cycling behaviour have undergone several transformations due to technological developments, in both bikes and other transport modes. As this master's dissertation focuses on the bicycle system, the evolution of other transport modes will be excluded from this paragraph. The focus will be on an inherent trend: the recent introduction and booming of the e-bike and freight bikes and its consequences.

The introduction of the e-bike was able to 'open up' the bicycle system as it, on the one hand, increased the popularity of cycling even more, where a decent system was already established (e.g. The Netherlands). On the other hand, in places where cycling was not popular yet, it is helping to overcome several barriers linked to traditional biking. As a traditional bicycle typically reaches an average speed of 15km/h, an electric one reaches a speed of 20km/h-25km/h. This implies that cyclists can now travel the same distance in a shorter time frame, or can travel longer distances in the same time. The latter can help to overcome an important threshold in rural areas. On top of this, less physical effort is required, which results which in a bigger target audience with respect to unfit and elderly people. The e-bike makes it easier for people living in a warm climate or near a relief with hills. Next to the general e-bike, also speed-pedelecs are introduced and can gain a speed up to 45 km/h. Furthermore, some e-bikes do not rely on pedal assistance anymore and reassemble more to mopeds than traditional bicycles [92].

The mobility report of 2021 by the Flemish mobility council MORA, reported that the amount of displacements performed by an electrical bicycle as main transport mode in 2019 is 2.85%, in 2015 on the other hand, this was still 0.81%. 2.21% of these displacements are currently under 5 km, this implies that there still is a big potential for small as well as for larger distances [102]. Furthermore, it is noted that a sales increase of e-bikes of 18% was observed in 2020 compared 2019. on top of this, the share of e-bikes holds almost half of the total amount of sold bicycles. Note that this sudden increase is partly due to the Covid-19 crisis where non-essential car rides where forbidden and where cities suddenly shifted towards a bicycle policy [104]. An example holds the Wetstraat in Brussels, where lanes for motorised traffic turned into cycle lanes. In this case, more cycle lanes, led to more cyclists.

Attention should be paid as this innovation also causes challenges to the bicycle system as it is established at this moment. First of all, the benefits of cycling that have been introduced in the previous sections, decrease. On the one hand, less physical effort will result in a lower impact on the health of the cyclists. On the other hand, the production of batteries and the use of electricity reduces the environmental benefits. Secondly, more attention has to be paid to cycling infrastructures as e-bikes have different requirements than traditional ones, for example due to the difference in speed. Several concerns are raised regarding the latter aspect from different parties e.g. regulatory, design requirements and safety requirements are being questioned. An example is the quote of the Dutch founders of VanMoof, who are designing high-end electrical bicycles and are planning to release a model with a speed until 50km/h: "We are exploring the option of geofencing, a kind of digital fence around the city. In between this fence, your bicycle will reach a maximum speed of 25 to 30 km/h and out of it, you will go faster." [115]. This safety concern is also raised by the public and as a result by activist groups. An example concerns the recommendations of Fietsberaad to the Flemish Government and cities concerning speed-pedelecs [41]. The city of Ghent has recently followed them in this advice.

Secondly, the popularity of freight bikes is increasing. The bicycles are able to offer a sustainable last mile solution for cars [92]. New policies, like for example low emission zones enhance this popularity. The same concerns are raised concerning safety requirements for -both existing and new- bike lanes that should be adapted to this new type of bike. Current cycle lanes are designed for bikes with smaller dimensions. Another example concerns the transport of children. Here, concerns are raised to the Nederlandse Fietsersbond about the quality of the roads that may potentially cause damage to small children [76]. Next, bicycle parking for freight bikes require larger space. Note that the success of these new bicycle concepts depend of the mindset accompanied by a given time frame and place as was made clear by the historical recap of the bicycle system based on the research of Ruth Oldenziel [82].

Lastly, it is noted that not only the cycling infrastructure is highly stressed by the increasing variance of its users, also the safety decreases. Numbers of the Belgian traffic institute VIAS have reported an increasing amount of accidents between cyclists, while the amount of accidents with other vehicles has been decreasing. Furthermore VIAS remarks that also the comfort is decreased for the general cyclists when the other shares are increasing [108].

These findings can also be connected to the quadruple helix as can be seen on figure 2.11.

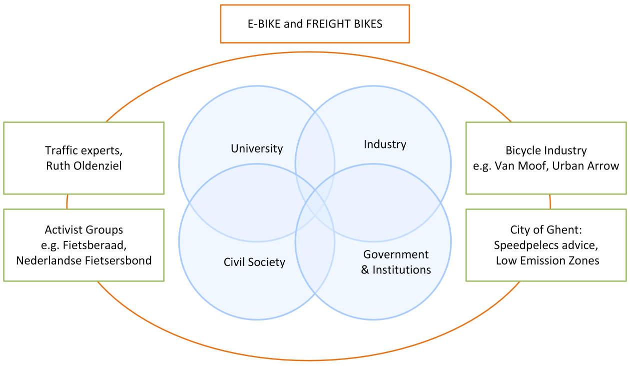


Figure 2.11: Quadruple helix: application on the booming of e-bikes and freight bikes

2.2.3.2 Integration of different Transport Modes and Systems

The concept of combi-mobility is currently being installed in Europe after several success stories funded by the European Commission around the continent in a search for more sustainable transport modes. Especially in urban environments, the bicycle holds an important role. [61]

The goal is to reduce the amount of private traffic and extensive road usage in city centres by placing certain mobility points at strategic locations. The concept of durability plays an important role in the need for "new" combined transport methods. In Belgium, this concept is introduced as "Hoppin Points" and promoted by the government. The idea is to design several hubs for shared and electric mobility. In Flanders, Mobipunt vzw is currently assisting municipalities and cities in order to implement the guidelines of the government. However, only one-sixth of the Belgian population in 2019 believed in the success of this new way of transport.[8] Accessibility and network connectivity are the most crucial factors. [23] Nevertheless, these concepts are not straightforward as they depend on cities and their environment and as the latter change as a consequence of demographical, economical, social and technological developments. Professor Dick Ettema, specialised in geosciences, social geography and planography at the University of Utrecht, studies these aspects. More specifically and related to this master's dissertation, he studies the travel patterns, health, social inclusion and durability of transport of people in urban environments. One of his research topics includes the impact of new transport modes e.g. mobility as a service, car and bicycle sharing on travel behaviour, accessibility and justice. [36]

Lastly, the inclusion of public transport is something which also ECF, the European Cycling Federation, is working on. In 2021 they raised awareness on this topic by launching their research concerning combined bicycle-train mobility: "How bike-friendly are Europe's rail companies?".

The general recommendations consisted of: (1) providing clear and enough information to the traveler, (2) increasing the acceptance rate of cyclists on trains, (3) make it cost effective, (4) increase the possibility for bike sharing or hiring at stations. A ranking was also made based on different points of interest: 60% of which dedicated to hardware components, 40% to software. A shared first place in the ranking was for the railway companies of Germany and The Netherlands, the second place for the Swiss railways and the third for Belgium. [40]

It is clear that integrated transport modes and systems are on the rise and that they are implying big opportunities on the one hand but lots difficulties and unknowns on the other hand when the bicycle system is integrated.

Once again, the quadruple helix model can be used to visually represent the ongoing developments in society and the knowledge economy. Figure 2.12 represents the result.

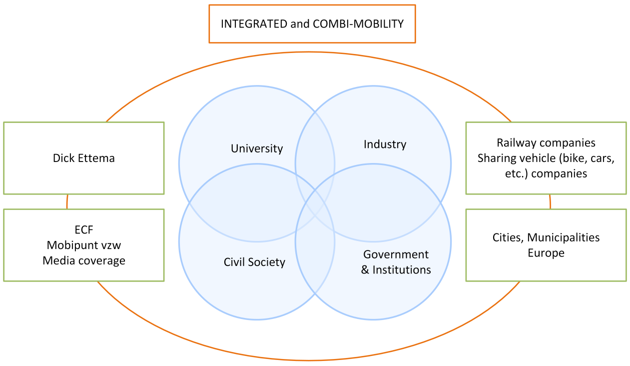


Figure 2.12: Quadruple helix: application on integrated and combi-mobility

2.2.3.3 Scarcity of Space due to a General Increase of Cycling

As a consequence of the previously identified developments (among others), the popularity of cycling is increasing. Of course, this is represented in the available data. The Flemish mobility report of 2021 by MORA (mobility council) reports an increase in ownership of bicycles as well as in bicycle usage [102].

Besides bicycles, also cars, trucks, busses, motorcycles, pedestrians, etc. make use of the current road system which is becoming saturated in space. The amount, length and duration of traffic jams has increased in a large amount over the years. These traffic jams are not only occurring on roads for motorised traffic, but also on cycle highways and normal cycle lanes. As a result, they have been included in the communication on the Belgian national radio concerning traffic jams. [7] To quote the VanMoof founders once more: "The success of the bicycle is becoming too large. It is just too busy. The problem is that that too much bike traffic is squeezed into too small bicycle lanes, while the car has all space. Amsterdam should enlarge the lanes, the city is hopelessly behind compared to other cities." Furthermore, the two brothers suggest to make parts of the city car-free and/or to decrease the maximum speed in the city center. [115]

It is clear that road and public space are becoming more scarce and tensions arise between the different stakeholders concerning the sharing and/or distribution of public space.[81] Furthermore, Henri Lefebvre's 'Right to the City' [93] has been taken up more recently by social movements, thinkers and progressive authorities as a call to action to reclaim the city as a co-created space.[77]. One of the causes of this space issue is related to the technological developments and massive presence of all traffic modes: new types of bicycles (bigger and/or faster), new types of active mobility (e.g. electric scooters), the increasing dimensions and popularity of SUV's etc. Nevertheless, the tensions cannot only be solved by looking at the dimensions of the different road users. This was proven by a case study of Copenhagenize 'The arrogance of space' in Paris, where they divided the road space in a static way amongst the different road users, figure 2.13 represents the famous result [21]. Moreover, it seems that distributing space according to model split is not the solution as the idea of 'fair road space distribution' ultimately relies on a simplistic logic. In reality it is a combination of political, social, technical and historically path-dependent processes as was argued by Samuel Nello-Deakin [77].

Other parameters that should, among others, be taken into account are the speed (and speed differences), travel behaviour and technological changes towards the future. Durable solutions have to be defined as a lot can happen in between the period of the theoretical design of a road system and the end of its service life.

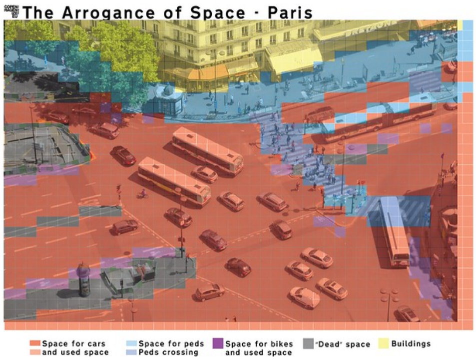


Figure 2.13: Copenhagenize: The arrogance of space - Paris [21]

Where the technological changes of the future and speed differences are plausible to predict, the behaviours of pedestrians and cyclists are still unknown. With an increasing amount of travellers that are turning to more sustainable means of transport such as walking and cycling -and even a bigger change in modal split is aimed by governments- it offers a lot of opportunities regarding future road design and understanding of active mobility to perform studies in this field. The behaviours of pedestrians and cyclists as well as their interactions with each other and with other modes of transport, are much more complex and hard to predict than those of drivers, due to the high degree of freedom in their decision-making process. This is due to the fact that they are less bound by traffic regulations. The latter also implies that their behaviour is totally different from motorised vehicles. These dynamics are exactly what the 'ALLEGRO - Unravelling slow mode traffic' project of Serge Hoogendoorn, Professor at TUDelft, is studying. The project is funded by the European Commission [59].

Finally, another quadruple helix can be used to represent the interactions in the field of road space distribution (figure 2.14).

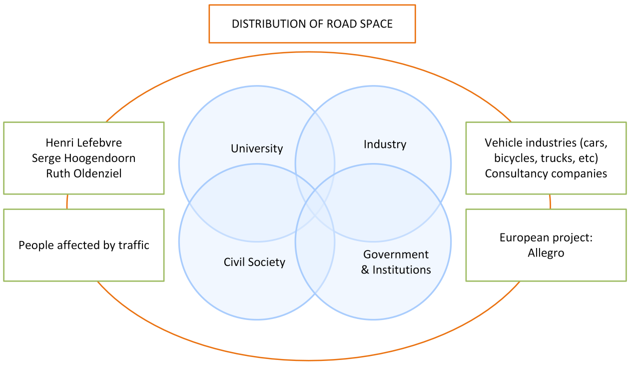


Figure 2.14: Quadruple helix: application on the distribution of space

Chapter 3

Methodology

3.1 General Approach

After this brief introduction and literary review concerning the bicycle system and its place in general mobility and space, it is clear that the concept holds a hold more than a bicycle and a cycleway. Furthermore, the current developments have indicated an explosion of interest, new fields of application and locations in which cycling will be or is being unrolled. In other words: the contemporary developments cause a very big impact and stress on the bicycle system. This aspect, together with the knowledge of the existing gap in terms of research with respect to effective cycling policies [55], has lead to the research questions that will be answered during this master dissertation - in a qualitative and consequently in a spatial-quantitative way. The latter analysis is performed with a major focus on road space and capacity. This was chosen because of the complex combined effect of space scarcity and the increased variety in cycling composition, as well as by the possibility to perform a technical analysis which is required for this dissertation at the faculty of engineering. The main topic and the two sub-questions are summed below.

Analysis of the resilience of available tools and methods to assess and design the bicycle system in Europe:

1. *What are the available tools to qualitatively evaluate the bicycle system and - given its stated definition, components and contemporary developments - how accurate are they?*
2. *How is road space, dedicated to the bicycle system, determined quantitatively - and how resilient are the methods with respect to the contemporary developments?*

The question remains: how can a city that wants to enhance its bicycle system, do this? And how can its level of expertise be assessed? What are the best example cities of good practice? This master's thesis will try to answer these questions regarding the **qualitative** aspect in the first part. More specifically, all assessment tools that have been found in literature with respect to the bicycle system in Europe, will be summed up. Afterwards they will be analysed and a typology will be set up. Lastly, their relevance with respect to current developments and challenges will be checked. The aim of this part is to provide an objective point of view towards the maze of qualitative assessments, as well as to provide a general overview. This will help both the spatial planners and academic's to enhance their work. Furthermore, it might inspire creators of the tools to make them even more accurate.

The second part of the master's thesis consists of zooming in on the **spatial-quantitative** part of the bicycle system. In specific, it will focus on cycleways, other spatial aspect such as parking space, docking stations, etc. fall outside of the scope of this thesis. The questions that will be answered are the following: how is road space divided and dedicated to the bicycle system? How does the current scarcity of space influence the development of cycleways in cities? What is happening in the academic world versus what happens in practice? Subsequently, several quantitative tools that have been found regarding the topic, will be used on two specific case studies. One is the Coupure Links in Ghent, Belgium and the other one concerns Haarlemmerdijk in Amsterdam, The Netherlands. The theory of the research will be compared to the applicability and relevance in reality. Furthermore, data has been gathered concerning the user intensities on the cycleways. This allows to make an estimation on how the theoretical capacity is related to the effective intensity. Furthermore, based on the insights that gave been gathered during the whole of the master's dissertation, suggestions will be made on how to enhance the bicycle system in the specific cases.

Note that case studies are not applied to the first sub-question with respect to qualitative assessments. This is because in essence, the tools have already been applied numerous times by the competent instances. Also not tools are openly available. Furthermore, in this master's thesis -with limited scope- it was opted to focus on the technical side of spatial-quantity.

As a final part of this master's dissertation, four **interviews** have been conducted from experts in the field. They were asked to share their insights, prospects and recommendations concerning the qualitative and spatial-quantitative parts of this thesis. As the case studies are situated in The Netherlands and in Belgium, it was opted to include two Belgian and two Dutch experts. Furthermore, it was made sure that the different experts could provide a valuable contribution from their personal background, so they have been chosen carefully. Their insights and suggestions have directly been implemented in the intermediate conclusions of the two big parts.

Lastly, a final conclusion will be drawn up and recommendations will be suggested with respect to further research in the academic world as well as to experts in the field.

3.2 Consulted Experts

A general introduction of the four experts that have been interviewed is provided below.

Joris Van Damme
Joris Van Damme is the first Belgian expert. He has a background in anthropology and is currently working for the province of Vlaams-Brabant. He is responsible for bicycle policies in the field of mobility and furthermore he is Project leader Cycle Highways. An important part of his work has been dedicated to the European CHIPS project -Cycle Highways Innovation for smarter People Transport and Spatial Planning- from Interreg [87]. The aim of the project is the following: 'To promote cycle highways as an effective and cost efficient low carbon solution for commuting towards and from urban employment poles. CHIPS will demonstrate that, especially in combination with the growing number of e-bikes, cycle highway innovation can effectively get commuters out of their cars.' [58]. More specifically he contributed to design the cycle highway manual, according to the model: Plan, Design and Build, Sell, Evaluate [37]. His biggest contribution lies in the planning part. In light of this, he helped to develop a cycle highway assessment tool. Practically, 22 criteria were identified and scored on a level of 4. Level 1 is considered as a threshold and level 4 as the highest level of maturity. This last level coincides with being future-prooff' which in essence, stands for including the whole system of HSO and context, for example providing places to rest or shelter in case of bad weather. Unfortunately, the tool was not made operational due to its high complexity. On top of all of this, Joris is part of the jury for the Vlaamse Fietsstadverkiezing of 2022.

Another one of his activities lies in designing a blog concerning the bicycle system [24]. Here, he raises concerns and suggests solutions about challenges he encounters and finds inspiring, mostly with respect to the bicycle system, but also to mobility in general. One of the core statements he wants to make coincide with what has been discussed during the introduction: a focus on cycleways is not sufficient in order to obtain a well functioning bicycle system.

Joris' practical experience in designing, in policy making, in contributing to a European project, in drafting a qualitative assessment tool, his engagement in the Vlaamse Fietsstadverkiezing and his broad personal interest and dedication to the bicycle system, make him the ideal expert to interview about the scope of this master's thesis.

Fabian Van De Velde
The second Belgian expert that is included is Fabian Van De Velde. He is a mobility expert at Stad Gent since 2008, since two years he joined 'Team Fiets' (Team Bicycle). Nevertheless he has been in contact with the bicycle system before as he contributed to the European Civitas project from which the first bicycle streets in Ghent followed. The project 'works to make sustainable and smart urban mobility a reality for all in Europe and beyond' [33].

Fabian was included in the interviews for this master's dissertation because he is familiar with the bicycle system in the City of Ghent and has worked on the Coupure Links. Furthermore, he has experience in the practical design of bicycle streets and cycleways in general [86].

Kees Vernooij
The third expert that has been included is Kees Vernooij. He is a mobility planner for the city of Amsterdam and is thus the first Dutch expert. Together with the second Dutch expert Olv Klijn and professor Robert van der Bijl he worked on the different design proposals of Haarlemmerdijk in Amsterdam, on which case study is based. Apart from this, he was able to provide very useful information with respect to the bicycle system in Amsterdam.

Furthermore, he contributed in enabling different innovative projects in Amsterdam. The most striking one concerns the Sarphatistraat, which basically holds one-way bicycle street in two directions separated by a tramway. Furthermore, he has experience with the main tool that will be used for the case studies and has spatially quantified numerous cycleways in Amsterdam.

On top of this, his big personal interest in the bicycle system resulted in unique insights and concerns that were able to be of great added value to this master's dissertation [88].

Olv Klijn
Lastly, the second Dutch Expert, Olv Klijn has been interviewed. Based on his architectural background, he founded FABRICations in 2007 together with Eric Frijters: a bureau for 'architectural design, urban plans and regional strategies for resilient cities' [39]. In essence, they work as future-proof spatial designers with a focus on durability in the field of energy, climate, biodiversity and quality of life. As a result, the bureau and Olv himself have worked on several projects related to mobility. In light of this, he also worked on the project of Haarlemmerdijk [89].

His knowledge about the case study and his ability to solve problems in an innovative and sustainable way which follows from his profession, made the interview with Olv Klijn an ideal addition to this master's thesis.

Chapter 4

Qualitative Assessments of the Bicycle System

After the introduction, it is clear that 'the bicycle system' as a concept, holds a very broad landscape of parameters: hardware, software, orgware and context. It can be concluded that it is not straightforward to compare or assess such a complex system. As a result, different instances have made an attempt at analysing and comparing bicycle systems in countries, cities or municipalities. This in a qualitative way. Based on the definitions that were explained in the introductory literary review and on the insights of the interviewed experts, 20 different assessment tools will be analysed, categorised and compared.

The tools that are considered are listed below:

1. International City Cycling Assessment by the Dutch Cycling Embassy, Favas.net, Bike-minded and Go Dutch Cycling
2. Global Bicycle Cities Index by Luko
3. Copenhagenize Index by Copenhagenize Design Co.
4. Worldwide Cycling Index by Eco-Counter
5. EuroVelo Barometer by Eco-Counter, ECF and EuroVelo Network
6. Urban Cycling Index by Wecity
7. The Bicycle Climate Test by ADFC
8. Grow Cycling City Toolkit by the ITDP
9. (Rapid) Propensity to Cycling Tool in the UK
10. Cycling Level of Service Assessment by Transport for London
11. City Ratings by PeopleForBikes
12. HEAT for walking and cycling by WHO
13. Cycling Barometer by ECF
14. BYPAD tool - EU-funded project
15. Bicycle Level of Service by Lowry et al.

16. Bikeability Index for Dresden by Technische Universität Dresden
17. Fietsstad by Nederlandse Fietersbond
18. Baromètre Parlons Vélo by FUB
19. Fietsgemeente by VSV and Fietsersbond

A wide range of different tools is evaluated. More specifically, it was opted to include several assessments originating from Dutch, Danish, Belgian and European institutional (or EU-funded) origin. This choice was made due to the important influence of Denmark and The Netherlands in 'the bicycle scene'. Furthermore, as was established in the literary review, Europe is increasing its focus on the bicycle system and therefore holds an important impact on the establishment of bicycle systems in its member states. Thirdly, a Belgian assessment tool cannot lack in this master's dissertation at the university of Ghent. On top of this, also tools originating from the main governmental bicycle institutions and advocacy organisations were included of neighbouring countries France, The United Kingdom and Germany. Lastly, an Italian and American tool -the latter with a focus on the analysis of European cities- have been included. The inclusion of the preceding, less famous, influential and/or more local tools, was seen as an added value in order to gain insight in how these countries perceive and analyse their (totally different) bicycle systems. A variety of 20 tools which qualitatively assess the bicycle system, was assumed to be sufficient in order to obtain a valid typology and draw meaningful conclusions with respect to future work and best practices.

A remark should made about the self assessment tool of the European Civitas Handshake project. Unfortunately, regardless of it looking like a promising all encompassing tool, during the writing of this master's dissertation, the tool was not published yet. As a result it was not included.

4.1 Existing Bicycle System Assessment Tools

This first section will provide the inputs, outcomes and operating principles of the 20 qualitative assessments that will be outlined. Note that they are randomly ordered. A comparison and typology will be provided below.

4.1.1 International City Cycling Assessment by the Dutch Cycling Embassy, Favas.net, Bikeminded and Go Dutch Cycling

The International City Cycling Assessment, ICCA, has been created for the aim of analysing and informing a city on how they can improve their cycling practices and conditions. Furthermore, it encourages the spread of bicycle practices rather than make a ranking. The tool grew from a collaboration between different dutch cycling advocacy's and experts: the Dutch Cycling Embassy, Favas.net, Bikeminded and Go Dutch Cycling [34].

More specifically, the ICCA assesses different cities over the world by the use of a questionnaire that is completed by local experts. The questions are both qualitative and quantitative answers and require data research and on-street observations. The dutch experts themselves, also pay a visit to the specific city. Five main domains, that coincide with the previously mentioned E5-model, are being focused on.

1. Mobility: Cycling as an efficient transport mode for urban accessibility
2. Space: Cycling as a contributor to liveable and safe cities
3. Economy: Cycling as an input to the urban economy and competitiveness
4. Environment: Cycling as a contributor to sustainable city and 'green' mobility

5. Social: Cycling as a contributor to healthy and socially cohesive cities

Furthermore, it includes the Hardware-Software-Orgware definition. The extensive inclusion of this definition of the bicycle system is perceived as one of the biggest strengths of this tool as it reflects the long-lasting experience of the Netherlands. Practically, table 4.1 gives an overview of all topics that are being assessed by the questions.

Topography	**Basic information about the city and its inhabitants**
	Maps Pictures Inhabitants Demography Topography Climate and weather
Context	**Current mobility and facilities**
	Example city History Facilities Other mobility
General	**General information about cycling**
	Cycling information Usage Users Accessibility Safety Experience
Hardware	**Physical Elements**
	Network and infrastructure Logistics Equipment Technology Bicycle Services Management and maintenance
Software	**Mental and virtual elements**
	Ideas and proposals Policies and programs Design and plans Budget Projects and protests Education and research Promotion and information Legislation and regulation Guidelines and standards
Orgware	**Organisational and institutional elements**
	Collaboration and organisation Administration and registration Decision-making fora Financing and finances Media

Table 4.1: Questionnaire topics ICCA

The results of the ICCA assessment include suggestions on what qualities have to be included in order to become a a cycling city and how a city can better improve their cycling practices and conditions. No index is made with the results, they are for internal use.

4.1.2 Global Bicycle Cities Index by Luko

Luko is an insurance company run by engineers and data scientists, situated in Berlin, Germany. Their corporate ambition is to combine technology and insurance in order to protect particulars [71]. In 2019, the firm conducted a city cycling assessment and ranked 90 cities over the world according to their performance. Luko clarifies that the study does not reflect the best and worst cities for cycling, but rather evaluates the cycling climate for these 90 cities based on several factors related to bike-users. The ranking is based on sixteen parameters in six general domains: the weather, the percentage of bicycle usage, crime and safety, infrastructure, sharing industry and events related to cycling. An exhaustive list of all parameters is given below.

- *Weather*
- *Percentage bicycle usage*
- *Crime and Safety*: bicycle theft score, number of fatalities per 100000 cyclists, number of accidents per 100000 cyclists
- *Infrastructure*: specialised roads and road quality score, investment and infrastructure quality score, number of bicycle shops per 100000 cyclists
- -*Sharing*: number of bicycle sharing and rental stations per 100000 cyclists, number of shared bicycles 100000 per cyclists
- *Events*: no car day, critical mass score

A distinction has been made between different sizes of cities according to S, M or L and scores have been normalised, but there is no distinction in the final index. The information and data for this analysis have been gathered by sources on the internet and local statistical departments. No local authorities or mobility and/or cycling experts have been contacted.

Finally, the acquired top 5 cycling cities by The Bicycle Cities Index is the following:

1. Utrecht
2. Munster
3. Antwerp
4. Copenhagen
5. Amsterdam

4.1.3 Copenhagenize Index by Copenhagenize Design Co.

The Copenhagenize Index was founded by Copenahagenize Design Co in 2011. The latter being a consultancy company offering services related to planning, design and coaching to support client cities, governments and organisations as they seek to become more bicycle-friendly. A small team of employers around the world are responsible for the index to which they refer as "the most comprehensive and holistic ranking of bicycle-friendly cities on planet earth" [16]. Every two years since 2011, an index has been made. The criteria have stayed the same since the beginning. More than 600 cities from all over the world with over 600000 inhabitants are in the database. Only the ones with a modal share above 2% are considered and furthermore, the amount of cities is narrowed by selecting the best from each country. In the latter, a selection process relative to country population size is used. Note that this implies fewer cities in The Netherlands and Denmark, which are generally considered as the most bicycle friendly cities. Finally, 118 cities are being analysed and ranked. On top of the ranking, suitable badges (e.g. rising star or newcomer) are given according to their performance. Only the top 20 is published afterwards.

More specifically, they analyse 13 criteria in 3 main domains (streetscape parameters, culture parameters, ambition parameters) and they add a 14th parameter which reflects extra impressive efforts or results that are difficult to see in the 13 other parameters. A schematic representation is given in table 4.2. No information is given considering the sources of information, e.g. (local) databases, potential experts, etc, neither a distinction in size of the city.

Streetscape Parameters	Culture Parameters	Ambition Parameters	Bonus Point
Bicycle infrastructure Bicycle facilities Traffic calming	Gender split Modal share for bicycles Modal share increase (last 10y) Indicators of safety Image of the bicycle Cargo bikes	Advocacy Politics Bike share Urban planning	

Table 4.2: Parameters Copenhagenize Index

Finally, the top 5 of the Copenhagenize index of 2019 is given below.

1. Copenhagen
2. Amsterdam
3. Utrecht
4. Antwerp
5. Strasbourg

4.1.4 Worldwide Cycling Index by Eco-Counter

Eco-Counter is a company that offers a complete range of specialized products for pedestrian and bicycle counting. It originates from Lannion, France and owns two subsidiaries: one in Montreal, Canada and one in Köln, Germany. Since 2014, the company has generated the World Cycling Index five times, based on their own counters which are installed across 39 countries to estimate the overall progression of bicycle traffic volumes by country and city [32].

Concerning the Worldwide Cycling Index of 2019, the analysis in 39 countries was based on a collaboration with 612 local governments, and 3266 counting sites with (1306 recreational, 1518 utilitarian and 442 mixed) validated data. Between 2017 and 2018 an overall increase of 6% in cycling activity has been noted, 3% when cycling for leisure is considered and 7 % for transport purposes.

The full report of 2019 consists of six domains: global progression, progression by country, top 10 cities with highest progression in bicycle count data, most cycled days of the year in 2018, cycling activity at night, hourly profiles for commuting per country. It is important to note that not all 36 countries are included in all calculations, thresholds have been adopted concerning the minimum amount of counters in the country or in the cities.

4.1.5. EuroVelo Barometer by Eco-Counter, ECF and EuroVelo Network

For the 2021 Velo-City edition in Lisbon, the EuroVelo Barometer has been created created by a partnership between the European Cycling Federation, Eco-Counter and the EuroVelo network [38]. The latter being a network of 19 routes, connecting all four corners of the European continent.

Using the technology of Eco-Counter as well as similar methods that have been used in their Worldwide Cycling Index, a data index is drawn up of 170 counting sites across 18 countries in order to check the bicycle volume trends across the network of European cycle tourism routes between 2019 and 2021.

The results measured a 2% increase of cycling on the EuroVelo network, +12% on weekends and -1% on weekdays. The latter is explained by different Covid-measures in different countries, resulting in more people working from home. Furthermore, half of the EuroVelo routes that have been analysed are seeing increased usage growth.

4.1.6 Urban Cycling Index by Wecity

Wecity is a sustainable mobility app founded in Italy in 2014. It promotes the adoption of sustainable mobility by collecting data from its 12000 users related to the cycling safety of 18 Italian cities and it has its own carpooling platform [113].

As a result, they have introduced the Urban Cycling Index which measures the safety of the Italian cities that are involved, on a scale of 1 to 5. The score is being calculated with an algorithm that takes into account the reviews, mapped miles, and city coverage percentage.

The top five safe of safest Italian cities is the following.

1. Faenza
2. Grossetto
3. Cesena
4. Mantova
5. Forli

4.1.7 The Bicycle Climate Test by ADFC

The Allgemeiner Deutscher Fahrrad-Club, the German Cyclist's Association, developed the Bicycle Climate Test based on the idea that cyclists themselves can assess their cycling environment by daily experience. The latter mainly focused on the cyclist's hometown. The objective was to identify the participant's satisfaction with cycling by combining its perception of cycling and its wishes and expectations [53].

As a result, the organisation developed a questionnaire with 27 questions in 5 main categories. An overview of the assessed parameters is given in table 4.3. Practically, the questionnaire is distributed for a period of three months by activists, cities, media, shops etc. A threshold is defined in terms of minimum participants for the publication of results depending on the size of the specific city.

After the analysis, the cities that satisfied the threshold, are given a score out of six and a ranking is made according to four city sizes (based on the number of inhabitants). Additionally, a distinction is made between the two categories: "Climber" and "Champion".

Cycling + Traffic Climate	Fun or stress Cyclist’s acceptance Everyone cycles Advertising Media reports
Value of cycling	Recent activities Parking offenders Road cleaning Traffic lights Winter services
Safety	Perception of safety Pedestrian conflicts Car conflicts Obstructions Bike theft Cycling on cycle paths
Comfort	Cycle path widths Cycle path surfaces Bicycle parking Construction detours Bicycle carriage
Infrastructure + cycling network	Town centre access Rapid cycling One-way streets Signposting Public bicycles

Table 4.3: Parameters Bicycle Climate test by ADFC

Lastly, it is noted that before the subjective ADFC test was introduced, the objective ADAC test was commonly used. The latter method was cancelled in the meanwhile due to the expensive and time consuming approach. Furthermore, the shift towards the importance of the opinion of the public had happened. Table 4.4 makes the comparison [12].

Subjective: ADFC Bicycle Climate Test (user evaluation)	**Objective: ADAC** Cycling in Cities test (municipal statistics, test procedures)
Cost efficient, high number of participants	Data collection costly/expensive
Results may be exposed to short-term media influences or manipulation	Hardly manipulable
Exact same survey method in all cities	Large fluctuations in availability of data and survey methodology
Covers all fields of bicycle planning and policy	”Objective” data is not collectable in all fields of bicycle planning and policy
Result depends on the level of ambition of participants	Stable time series possible
Direct measurement at the target object	Indirect measurements by indicators describing conditions

Table 4.4: ADFC vs ADAC test [12]

4.1.8 Grow Cycling City Toolkit by the ITDP

The Grow Cycling Toolkit has been introduced by the Institute for Transport and Development Policy in the USA. The latter being an umbrella organisation that has been founded in 1985 for several worldwide peace and development initiatives as well as advocacy efforts. Their aim is to "challenge different institutions to pay attention to bicycling and walking and the transport needs of the poor", the latter on a global scale [44].

The toolkit itself is designed in order to help cities create a tailored action plan to quickly grow and improve cycling as well as lower barriers that prevent people from cycling in a specific city. More specifically the aim is to guide governments in the implementation of policies by identifying immediate steps to address specific barriers as well as providing foundations for a long-term vision. The toolkit is not intended as a comprehensive resource for the design and implementation of specific actions but rather refers to external resources that provide better guidance in that aspect.

An online questionnaire of 17 questions lies at the basis of the Rapid Cycling Growth Toolkit. This represents the first part, "the city self-assessment". It contains questions about the 6 following parameters of the bicycle system.

- Bicycle access (3 questions)
- Security (2 questions)
- Safety (4 questions)
- Awareness (4 questions)
- Physical Conditions (3 questions)
- Capacity (1 question)

Secondly, a list of potential measures will be shown. It is then asked to select the ones that have already been implemented in the city, in order to made a correction. In the last step, an action plan with a top 10 of measures will be generated based on the current capacity and the highest needs. The specific actions are divided among three main areas: infrastructure, policies and education or awareness-building. Furthermore, they have been prioritised according to their impact on the six considered parameters and can then be sorted based on cost, time and needed capacity.

4.1.9 (Rapid) Propensity to Cycling Tool in the UK

The **PCT** or the Propensity to Cycle Tool is an open source strategic planning tool created by the collaboration of different doctors from several universities located around the United Kingdom (Cambridge, Leeds, Westminster, London) in 2017. It aims at assisting transport planners and policy makers to prioritising investments and interventions. More specifically it answers the following question: 'Where is cycling currently common and where does cycling have the greatest potential to grow?'. The can also be used on a smaller scale, for example to estimate the future share for cycling on a specific corridor [69].

It should be noted that the tool is limited by the geographic resolution of origin-destination data (measured by sensors) as well as limited in scope due to the use of hypothetical national scenarios of cycling increase. The latter are given below.

- Go Dutch: The case where people would have the same likelihood to cycle as people in the Netherlands.

- E-bike: Assuming that people use the e-bike for longer trips or more hilly trips.
- Government Target: Short term doubling of cycling towards 2025.
- Gender Equality: The case where no difference would be perceived in the likelihood of men vs. woman who cycle. Currently, 75% of cycling commuters are men in England.

Making use of this methodology, the **RPCT** or Rapid Propensity to Cycle Tool has been developed at the University of Leeds [94]. By this tool, existing cycleways, promising locations for new cycleways and cohesive long-term cycle networks are being identified.

On the one hand, roads are being ranked by their 'cycling potential' defined by the PCT under the assumption of the government target. In addition, only roads with enough spare space are being considered. This approach has been adapted as new cycleways on these routes would be faster to deliver and as they are more likely to represent the key arterial routes. Both factors resulting in a larger increase of cycling volumes. Nevertheless, different limitations follow from this approach as the value for money aspect is not considered, only trips regarding school and work are being considered and the best locations for new cycleways might also be situated on roads with not enough spare space.

On the other hand, the tool identifies what a 'cohesive network' for cycling might look like if we were to consider a wider range of interventions (e.g. closing roads to motorised traffic or creating one-way systems). In order to obtain this network, all high cycle potential corridors are included, also the ones with not enough free space. It is important to note that routes under 500m are not considered and although the tool provides some indication of what a cohesive network may look like, it doesn't prioritise the best type of intervention for a given location.

Finally, the results are visualised on a map of England together with various data for specific areas: cycling potential, length of continuous cycle network (including the existing network), current speed limit and whether or not the road is considered to have enough free space.

4.1.10 Cycling Level of Service Assessment by Transport for London

The Cycling Level of Service Assessment or CLoS is an audit tool developed by Transport for London. The latter being a local government body responsible for most of the transport network in London, England [29]. The assessment aims at assessing the quality of cycling provision in existing and proposed schemes by assigning a score on 100.

The assessment takes into account six main parameters: safety, directness, coherence, comfort, attractiveness and adaptability. A full overview of all parameters is given in table 4.5 (for some categories, in reality, even a more specified break down is used). All parameters are given a score of 0, 1 or 2, depending on the quality of the requirement. Zero scores do not meet the required standard, a score of one corresponds to good and a score of 2 to highest quality. Some of the factors are considered as critical and as a result, there score is doubled. The latter parameters are indicated with a '*' in table 4.5.

Safety	*Collision risk *Feeling of safety Social safety
Directness	Journey time Value of time Directness
Coherence	Connections Way-finding
Comfort	*Surface quality Surface material *Effective width without conflict Gradient Deflections Undulations
Attractiveness	Impact on walking Greening Air Quality Noise pollution Minimise street cutter Secure cycle parking
Adaptability	Public transport integration Flexibility Growth enabled

Table 4.5: CLoS assessment: parameters

The assessment should be completed by the designers and clients, but it can be useful to include the bicycle system users as well. The latter is most important when subjective judgements are needed, e.g. safety or the perception of a risk.

4.1.11 City Ratings by PeopleForBikes

People For Bikes is an American advocacy organisation based in Colorado that aims at making cycling more popular and improving the bicycle system by empowering cities to take action, by connecting different instances and by supporting the bike industry. In the context of its company goal, People For Bikes developed ”City Ratings”, a tool to assess the bicycle system in the U.S. [10]. In 2020, the tool went global in order to be able to compare the progress of cycling in the United States of America to the world. More specifically, it currently analyses 767 cities in 12 countries worldwide of which 660 are located in the U.S. and 107 are international. The eleven internationally considered countries include Australia, Belgium, Canada, Denmark, France, Germany, Italy, The Netherlands, Norway, Spain and the United Kingdom. The City Ratings are annually performed and released. The tool gives a score on 100 to each city of which 80 points are dedicated to the 'Network score', representing the quality of a city's bicycle. The other 20 points are dedicated to the 'Community score' which measures how people feel about biking in their city, their perception.

First, the network score is generated based on PeopleForBikes' Bicycle Network Analysis, the BNA. It concerns a tool that analyses the quality and connectivity of a city's bicycle network. It includes six different parameters, represented in table 4.6. All of them measure the connectivity and accessibility by bike of inhabitants of a specific city to the parameter. This happens by rating every street or path as high or low (safe, comfortable for people of all ages and ability to ride a bike) stress for people riding a bide. Next to the streets, also the intersections are rated.

In order to perform a correct analysis of the six parameters, all destinations in the city are first grouped according to: neighbourhood, opportunity, essential services, retail, transit.

People	connectivity to other people
Opportunity	connectivity to jobs and education
Core Services	connectivity to critical (food and healthcare)
Shopping	connectivity to retail districts (both goods and services)
Recreation	connectivity to nearby parks, community centres, etc includes off-street bike paths and trails
Transit	the connectivity to rail stations and major transit hubs

Table 4.6: Network score: parameters BNA

Secondly, the community score is generated by the PeopleForBikes' community survey, which is an annual online survey to understand the perception of biking in a specific city. A score on 100 points is given based on an evaluation of four categories, which are listed and explained in table 4.7. A threshold has to be reached in terms of amount of participants of the survey in order to be included in the City Ratings, this number lies between 25 and 100 depending on the population size.

Awareness	perception of acceleration awareness of events taking place in the city awareness of facilities in the area
Safety	agreement with a safety-related attitudinal items
Network	perception of quality of bicycle network
Ridership	frequency of riding types of transport recreational bicycle riding

Table 4.7: Community score: parameters

It is important to note that the procedure to determine the City Ratings has been changed significantly in the last two years. First, the number used data sources has been reduced from six to two (OpenStreetMap and national census statistics). Next, before a survey was given to city staff in order to get a better view at the safety and the acceleration that is happening in the city. As some cities did not submit the survey, it has been taken out of the assessment in order to increase data consistency. Lastly, it is clear that a big focus goes to the network structure. This approach is justified by PeopleForBikes as 'Research shows that the best cities to ride have safe, comfortable, connected bike networks. Building better bike infrastructure is the key to increasing ridership, improving safety, and working towards equitable mobility.'

In consulting the rankings, a region of choice can be selected, e.g. Europe or a city size in terms of population (small, midsize and large). The European Top 5 cycling cities (independent of size) according to City Ratings are:

1. Zwolle
2. Utrecht
3. Groningen
4. Amsterdam
5. Copenhagen

4.1.12 HEAT for walking and cycling by WHO

The Health Economic Assessment Tool, HEAT, by the World Health Organisation recognises and quantifies the economic benefits of walking and cycling [62]. More specifically it estimates the value of reduced mortality that results from specified amounts of walking or cycling. Different benefits are being considered: physical activity, the exposure to air pollution, injuries by traffic crashes and the effect of carbon emissions from shifting travel by motorised modes to walking or cycling. The tool is aimed to be used by professionals, but is available online [84], and can be used for different kinds of analysis:

1. Assessment of current (or past) levels of cycling or walking
2. Assessment of changes over time
3. Evaluation of new or existing projects, including benefit-cost ratio calculations

Practically, after defining what kind of assessment that you want to perform, the input data is required: volumes of travel (duration, distance, trips, steps, frequency, modal share and shift) and population size. In the next step, the following parameters are calculated:

- Physical activity benefit: reduced mortality risk from walking and/or cycling:
- Air pollution risk: mortality risk when walking and/or cycling
- Crash risk: mortality risk when cycling
- Carbon: reduction in emissions from substituting motorised modes

Subsequently, these parameters are transformed into quantitative values for reduced mortality and carbon emissions (both aggregated and mode and pathway specific). Lastly, these numbers are monetised to a value of a statistical life or to the social costs of carbon.

It is important to note that to tool is not to be applied in environments with a very high level of air pollution or for (sub)populations with very high average levels of walking or cycling. The latter limitations are important because respectively the effects of concentrations of fine particulate matter of more than 50ug/m3 have not yet been well studied and the benefit of physical activity starts to decrease from 1.5 hours of cycling and 2 hours of walking per day [63].

4.1.13 Cycling Barometer by ECF

The Cycling Barometer by The European Cycling Federation has been created for the attempt to put the cycling landscape of each EU member state in perspective [49]. By the creation of this tool, the federation wanted to draw attention to the fact that cycling policies should be backed and monitored with proper data and that the latter is still lacking.

More specifically, the cycling barometer gives points to each of their five categories by the use of five EU-wide surveys. They have been chosen because they represent the key fields addressed by ECF's for cycling advocacy in Europe. The total sum is made up and like that member state countries can be ranked. The categories are summed up below as well as the methods and data sets used for the calculation [31].

- Bicycle modal share: EU barometer survey of preferred daily mode of transport - snapshot at one moment
- Road safety: Comparison between cycling fatalities from CARE database to the number of daily cyclists
- Cycling tourism: Volume of cycling tourism market calculated by the European parliament

study

- Number of cycling advocates: numbers of recognised cycling advocacy organisations from membership figures of ECF affiliated groups
- Bicycle sales: data for the state of the market from the Conebi market profile

The top 5 final results for the ECF Cycling Barometer of 2015 are the given below, both in the five different fields, as well as a total.

Ranking	Modal share	Safety	Tourism	Advocates	Market
1	Netherlands	Luxembourg	Finland	Slovenia	Denmark
2	Denmark	Malta	Sweden	Lithuania	Luxembourg
3	Hungary	Sweden	Hungary	Denmark	Belgium
4	Sweden	Netherlands	Netherlands	Croatia	Netherlands
5	Finland	Denmark	Denmark	Netherlands	Germany

Table 4.8: Ranking in 5 criteria

Finally, the summation of the different points in the categories (not weighted) results in the following overall top 5 according to the Cycling Barometer by ECF in 2015.

1. Denmark
2. The Netherlands
3. Sweden
4. Finland
5. Germany

It should be noted that in the version of 2013, The Netherlands and Denmark shared the first place but the latter afterwards took the lead because of its high level of cycling advocates (even though The Netherlands led most of the variables).

Different remarks are made concerning the limitations on data and to which extent the different data of different countries can be compared to each other. First, it is noted that the cycling data is not all from the same period. Secondly, no weight has been given to the different criteria. Thirdly, due to different relative purchasing power in the member states, markets values might not be comparable. Lastly, it is noted that due to different NGO membership structures in different countries, advocates number calculations differ.

4.1.14 BYPAD tool - EUfunded project

In 1999, the European Commission funded the Bicycle Policy Audit, BYPAD project, in order to develop a quality management tool which on the one hand indicates the quality level of the cycling policy in cities and on the other hand prepares a quality/action plan for this cycling policy [46]. The tool itself has been developed by an international consortium of bicycle experts. It is based on international best practice methods and provides an overview of the applied measures and structures in local cycling policy. Furthermore, it has already been implemented in almost 250 towns, cities and regions over 25 countries.

The BYPAD tool considers cycling policy as a dynamic process, a whole of nine fields, in permanent development, influencing each other. The nine modules ensure a balanced cycling policy and are divided in three main domains: actions, monitoring and planning. A quality score is assigned to each field. An overview is given in table 4.9 [5].

Planning	User needs Leadership and co-ordination Policy on paper Means and personnel
Actions	Infrastructure and safety Information and education Promotion and partnerships Complementary actions
Monitoring	Evaluation and effects

Table 4.9: Bypad: cycling policy as a dynamic process

The principal item of BYPAD is the questionnaire, which consists of 30/22/18 questions covering all aspects of cycling policy for cities/towns/regions. For each module, a number of questions are contained, whose answers are preset between a quality level of 0 to 4. Level one to four respectively represent an ad hoc-oriented approach, an isolated approach, a system-oriented approach and an integrated approach. Using this method facilitates finding the weakest link of the considered system in an easy way, as well as provides the city/town with direct incentive and inspiration to climb to the next quality level.

The process of evaluation and quality improvement is carried out by a local evaluation group. The latter consists of politicians responsible for cycling, policy makers and executive staff of the municipality dealing with cycling, and representatives of the local cyclists' user organisation(s), who use the 'product' of the local cycling policy. Bringing these three different players together, BYPAD assures that the local cycling policy is examined critically from different perspectives. Furthermore, this process is evaluated and supervised by an external consultant, the latter being a certified BYPAD auditor. After all stakeholders complete the questionnaire individually, a confrontation and consensus meeting is set up and a quality plan is made up.

Furthermore, it is important to note that BYPAD is meant as an internal tool of evaluation and is not fit for comparing different cities.

4.1.15 Bicycle Level of Service by Lowry et al.

The BLoS, or Bicycle Level of Service is a method that calculates the bicycle suitability of a specific place. It is based on a previous bicycle level of service publication of the Highway Capacity Manual, which worked for linear and linked street segments by certain criteria such as the width of a bike lane, vehicle traffic volume, vehicle speed and pavement conditions. Now, for this index, the BloS value is enhanced with the concept of accessibility in order to calculate the bikeability [64].

Formula 4.1 represents the calculation of the accessibility A_i of a location i, by the product of the importance E_j at a location j with $f(r_{ij}$. The latter representing the impedance function for travel time, distance or costs from location i to j. The results vary between 0 and 1. The highest values represent the routes with the highest bikeability or accessibility are represent either short routes or a high bicycle level of service [70].

$$A_i = E_j * f(r_{ij}) \tag{4.1}$$

Finally, the method uses GIS software analysis to result in a grid-based map that represents the bikeability. As this method solely relies on data, it is important to note that it cannot be applied on every street, everywhere.

4.1.16 Bikeability Index for Dresden by Technische Universität Dresden

The Bikeability Index for Dresden originated from a research project at the University of Dresden. It considers seven different factors and gives them a qualitative value for every square of 100m by 100m. The considered factors are the following [64]:

- Bicycle infrastructure
- Existence of structurally-separated bike lanes
- Green area and water surface
- Topography
- Land use
- Bicycle facilities
- Traffic load

The resulting sum of values associated to the factors for each square, represents the bikeability of the respective cell. Furthermore, the cell information for every criterion is addressed via weighted overlay analysis, designed by McHarg and is related to map algebra [50].

4.1.17 Fietsstad by Nederlandse Fietersbond

Every two years, a 'Cycling city' of the year is elected by the Nederlandse Fietsersbond. The assessment that lies behind it is based on both, a quantitative study and a questionnaire [42]. Every town or city automatically participates to this election on the condition that at least 50 questionnaires have been filled in. This questionnaire consists of 28 questions in 5 different areas. The questions are to be answered by giving a rating between 1 and 5. On top of this, people are required to indicate what type of bicycle they use, how often they use it and if it is electrically powered.

1. 8-80
   The topic 8-80 refers to how it is perceived to cycle in the city as a vulnerable cyclist. For example 8 and 80 year old people.
2. Experience
   The questions related to experience verify the general perception of cycling e.g. if cycling is experienced as stressful or if people feel like the city is acting towards improving the situation.
3. Maintenance
   Next, questions are asked concerning the maintenance of the cycleway e.g. in winter, dewatering and cleaning.
4. Network
   Network questions are related to how easy it is to reach your obtained destinations e.g. detours, the number of stops that are required.
5. Infrastructure
   Lastly, the perception of the infrastructure is checked e.g. comfort of the cycleways or traffic lights.

The quantitative study is based on the following 4 parameters. To every factor, a score between 1 and 5 is awarded.

1. Detour Factor
   The detour factor is determined by measuring how much kilometre actually has to be cycled in order to reach points that are in a 1km radius from a central point in the city. The shorter the distance, the better the score will be.
2. Urban Density
   The second parameter allows for cities with comparable size to be compared based on how dense the city has been built. This factor was chosen as the more dense the city, the closer different destinations will be.
3. Roundabouts
   Concerning roundabouts, the design of the infrastructure is checked on allowing cyclists to get priority.
4. 50km/h
   Lastly, it is checked if roads that have a speed equal to or higher than 50km/h have a separate bike lane or share the road with automobiles.

Finally, an average score between 1 and 5 is obtained for each of the general 5 subjective and 4 quantitative topics. A final score is than obtained by generating a weighted average where the subjective data from the questionnaire is giving twice its importance. Together with the chosen cycle city, different results are published: the scores per category, per questions and per city as well as the number of completed questionnaires per city, the top 100 and the fastest climbers compared to the previous edition.

4.1.18 Baromètre Parlons Vélo by FUB

The Baromètre Parlons Vélo is an initiative of FUB in France or the Fédération Française des Usagers de la Bicyclette. The tool is based on a questionnaire which can be completed online for a couple of months by everyone who is interested. It aims at receiving feedback from the users of the bicycle system in order to include the findings in future plans. The number of participants in 2019, made it the biggest existing cycling barometer [72].

Practically, the tool consists of 26 questions to which an qualitative answer ranging from 1 to 6 can be given. The questions are situated in five main domains, which are given below [45].

- Safety
- Comfort
- City effort
- Evolution and data
- Parking services

Furthermore, the barometer addresses challenges that cyclists encounter on a daily basis due to a mapping function.

The results of the barometer are only published when more than 50 participants have completed the survey. Each city that makes this threshold, is than categorised into a class ranging from A+ to G depending on the perceived bicycle climate. Furthermore, the report includes the three most dangerous places for cycling for each specific city, black spots and priority routes [112].

4.1.19 Social cost-benefit analysis

A social cost-benefit analysis is a method that is used to judge or compare projects, mostly related to governments, in an integral way [73]. It operates from a 'welfare theory' where all costs of a new measure or project are compared to its effects (positive and negative). It does not just take into account the direct monetary costs, but also factors to which people attach importance, e.g. an affected living environment. In general, a social cost-benefit analysis operates according to the following steps [73]:

1. Analysing the problem that the project or measure is trying to solve.
2. Analysing what would be the result of the project or measure is not carried out.
3. Estimating the effects of the measure or project per year by comparing it to the zero project alternative. This concerns physical effects but also the effects of the latter to the general welfare (e.g. recreation, health, etc). This analysis often starts from traffic models, financial analysis or environmental reports.
4. Monetising the effects found in step 3 for different year.
5. Recalculating these financials to one basic year.
6. Summarising the findings in a final report. Make a distinction between the social cost-benefit analysis of different regions, e.g. country, city, nearby towns.
   Noting non-quantifiable effects.

The benefits of this kind of approach consist of having a quantitative idea of what the project consequences will be (both in terms of effects and costs). This results in the possibility to re-evaluate or optimise the need/purpose/scope of the project. Next, it provides an objective look into the situation, as well as the possibility to compare. Lastly, the transparent approach highlights points of discussion that can arise from the beginning.

In what follows, an examples will be highlighted. The first one is a **Dutch social cost-benefit analysis or MKBA** (Maatschappelijke Kosten-Baten Analyse) performed by Decisio [26]. The latter being an economic research company from the Netherlands, focusing on mobility and infrastructure, sustainable energy and water, regional and urban economy, market analysis and effective governments. The MKBA investigates what the gain to the **city of Utrecht** would be if bicycle usage would increase.

The report is based on the changes in modal split in Utrecht between 2010 and 2015. The change in numbers show the effects of the policy that has been implemented over the years, e.g. investments in bike parking and better connections. Several interviews and samples have been collected as well. The results show a total social benefits of 250 million euros, consisting of an increase of life expectancy, climate and air quality, travel time and reliability in car traffic (72%), absenteeism reduction, noise, savings on public transport subsidies, accidents. Furthermore, a direct economic benefit of 38 million euros was calculated (contribution to national income).

4.1.20 Fietsgemeente by VSV and Fietsersbond

The elections of Fietsgemeente hold an initiative of Vlaamse Stichting Verkeerskunde in collaboration with Fietserbond Vlaanderen [109]. The aim consists of inspiring Flemish cities to become cycling cities, to inspire them and to stimulate them. The process consists of two rounds and is held every two years.

The first round consists of a survey which is spread around the general public during a certain period. There are 15 questions spread over three categories: experience, infrastructure and communication. Each question has the same importance with respect to the final score and should be answered with a qualitative value between 1 and 5. Starting from 50 completed questionnaires, a city is included in the comparison. The results for every city that makes this threshold are put online and a comparison is made with respect to the score of the previous year (if available). An important note holds that the winners of the previous year are not allowed to participate again in this last round, they are excluded for one year.

Afterwards, nine cities will be nominated based on the results. They are spread equally in the three considered categories according to size: big cities (more than 50 000 inhabitants), medium cities (between 20 000 and 50 000 inhabitants) and small cities and municipalities with less than 20 000 inhabitants. In each of these categories, a winner will be elected. The latter is done by an extensive audit by an external independent agency. The agency uses a 'quick scan' method with a focus on policy, monitoring, evaluation, safety, networks, design, infrastructure, bicycle parking, bicycle culture, modal share and average appreciation. Furthermore, the agency performs a site visit and works on an objective report for all nine cities. Finally, these reports are presented to a jury who will choose the three winners.

The winners from 2020 are represented below for respectively the big, medium and small city category.

1. Kortrijk
2. Deinze
3. Boechout

4.2 Comparison of available Tools

Even though all tools that have been analysed in the previous sections, somehow qualitatively assess the bicycle system, it is clear that they all have different aims and methods. In order to continue with this analysis and in order to make a useful comparison, first, a typology has to be made of the available literature. This will be done based on different levels, the distinctions are further explained below. Furthermore, also the motivation of each distinction will be explained either by an example or by a general fact.

- **Bicycle System or Cycling Benefits?**
  The first question that should be asked is if the tool is analysing cycling and the system itself or if it is analysing the effect(s) of cycling, e.g. health or economic consequences. In what follows, the focus will be on the bicycle system itself, not on its benefits. Therefore -even though they yield very valuable insights on their own- the WHO HEAT tool and the social cost benefit analysis will not be further discussed in the scope of this master's thesis. In what follows, tools assessing the bicycle system are further divided into a typology and compared.

- **Evaluation or Ranking?**
  Secondly, a clear distinction should be made between tools that are assessing and/or evaluating the system and tools that are providing a ranking and/or comparison of different systems. This holds a rather basic separation as both tool-types have different outcomes and aims and as a result, they cannot be compared.

- **Current State, Ambition or Growth?**
  Thirdly, it is noted that different results are obtained depending on the focus over time of the analysis. This can either be the current state of a system (1), its growth (2) or the ambition and actions that are being developed in order to improve the system (3). Especially when different rankings are considered, this factor can lead to very different outcomes.
  The separation of growth and current state is further motivated based on an example. The city of Antwerp is only considered as a top cycling city when the concepts of current state, ambition and growth are mixed. In practice, it is clear that Antwerp does not reach the same level of establishment of its bicycle system than for example Amsterdam or Copenhagen. On the contrary, it is more easy for a city like Antwerp to double the quality of its system than for a city were the bicycle system is already well deployed.
  Lastly, the inclusion of ambition into the tools is discussed. It is clear that ambition, meaning the future aims or goals of cities or countries, is not to be mistaken with the actual current state of their bicycle system. Often these goals are defined on the long run or are never to be converted into reality. Note that it is not said that growth or ambition are not relevant parameters. Nevertheless, it is important to understand the implication of the inclusion of these parameters.

- **The Origin of the Tool**
  Subsequently, one should pay attention to the founder organisation of the tool, as this might have a big influence on what the actual or underlying goal of the creation of the tool consists of. In this analysis, four groups are distinguished.

  1. Advocacy based organisations
  2. Institutional or governmental
  3. For profit companies offering services related to cycling
  4. Independent parties (e.g. scolars)

As was mentioned before, it is clear that these different parties essentially have different objectives or benefits associated with the creation of tools. An example holds the possibility that a for profit company might be implementing/designing a tool solely for marketing purposes. This can result in a mismatch between purpose and knowledge. As a result, the tool might be less encompassing or accurate than for example a tool designed by independent scolars. On the other hand, a tool originating from a purely advocacy based background, might also be less accurate.

- **Internal Insights or External Comparison?**
  Furthermore, it is important to differentiate assessments -which are classified as evaluation tools (not ranking)- according to their use. More specifically; on the one hand tools can be used internally on the demand of local governmental/institutional organisations in order to gain insights into the current state/growth of the bicycle system. All of this while the involved stakeholders are assisting in the assessment. This type of application will result in an individual internal report, accompanied with suggestions. On the other hand, tools can be used with the aim of external communication, assessment or incentive creation based on the initiative of a stakeholder in a larger environment.
  In other to clarify: Bypad will be classified as an internal evaluation tool as assessors from the city itself are evaluating the bicycle system with the aim of improving it. The Eurovelo Barometer on the other hand, is an external tool that evaluates the growth of the bicycle systems in specific places, based on the incentive of ECF and Eurovelo. The separation between these types is of great importance as the outcomes and methods of the tools will be incomparable.

- **Choice of Scope and Scale**
  Next, when making a distinction between different tools; the scope and scale should be clearly evaluated and defined. The scope can either be the world, the EU, a country, a city or a combination of these. The scale -inside this scope- on the other hand can be countries, cities, corridors or can even be grid-based. Furthermore, it is important to evaluate how the choice of inclusion inside the scope, e.g. 'why is city A in in country X, but city B in the same country X excluded'.
  This distinction was included as some tools work with a fixed number of cities or countries, while others maintain inclusion criteria (e.g. a minimal number of respondents to a questionnaire, a minimum number of inhabitants, etc). In this way, the city that scores best in one tool, can be excluded in another tool and therefore its bicycle system could be (incorrectly) perceived as less valuable.

- **Parameters taken into account**
  It is important to note that not all assessments include the same parameters that are investigated or analysed. Furthermore, the amount of parameters that is assessed, is an important factor as well. Naturally, the more parameters that are considered, the more representative the result with respect to the whole bicycle system will be. For the sake of simplicity, not all parameters are compared in detail, but a focus is put on four main concepts:

  - HSO (hardware, software, orgware)
  - Network or accessibility check
  - Modal share of cycling
  - Infrastructure not only focused on cycleways itself

  Note that, as was made clear during the literary review, in reality a lot of other parameters should be taken into account in order to fully assess the system. Nevertheless, in this case the scope will be limited to these four as they yield important implications to the final result and the accuracy of the assessment. Furthermore, they represent commonly 'forgotten' features. Apart from the degree of accuracy of the assessment that depends on the amount of parameters, also the comparison between different outcomes of assessments will be influenced due to a seemingly worse or better outcome.

- **Used data**
  Big differences are obtained when investigating the origin of the data that is used for the performed analysis. First, the two biggest distinctions hold subjective data resulting from questionnaires and objective data which has actually been measured. Furthermore, objective data can result from local/global sources or even from site-measurements. When considering questionnaires, thresholds of quantities, concerning the acceptability with respect to the representation of the population, are important. The latter note is made as the amount of respondents can make the results representative or not. Furthermore, not only the amount is important, also which people are assessing the system. Often, the people responding to surveys have a great (dis)interest in the topic. This might result in unrepresentative outcomes. Furthermore, also professional assessors of a specific city might fill out the assessments in a biased way. Therefore it might be useful for a third party to complete the analyses or to get the data in order to obtain an objective result.

- **Calculation method**
  Finally, the method according to which the final result has been calculated is of great importance. Several tools tend to use a weighting system towards parameters of which the creators believe they are more important than others. This should be considered and checked as different tools, taking into account the same parameters, but a different weighting system, will have a different outcome.

Note that this does not hold an exclusive list of distinctions and attention points. The remarks were chosen as they were reflected by the literary review that has been conducted, by laying out the tools next to each other and by the input of the experts. Furthermore, it is clear that some points will have a greater influence on the results than others. Nevertheless, no weighting has been considered in this case as a more detailed statistical analysis should be performed.

4.2.1 General Typology

Finally, all distinctions of the previous section have been applied to the 20 qualitative assessment tools. The result can be found in appendix A. One can conclude that no tools have been designed in the exact same way. As a result, making an exact comparison is not possible. Nevertheless, a general typology has been defined. Figure 4.1 represents a schematic visualisation of this typology, accompanied with the tools that have been assigned to the specific levels.

Three main types have identified in terms of qualitative assessments of the bicycle system (Note this colour combination will return in the following paragraphs):

1. External evaluation tools (green)
2. Internal evaluation tools (orange)
3. Ranking tools (blue)

Furthermore, an important distinction is made between tools that are solely analysing the current state of a specific bicycle system and tools taking into account the growth or ambition on top of the current state.

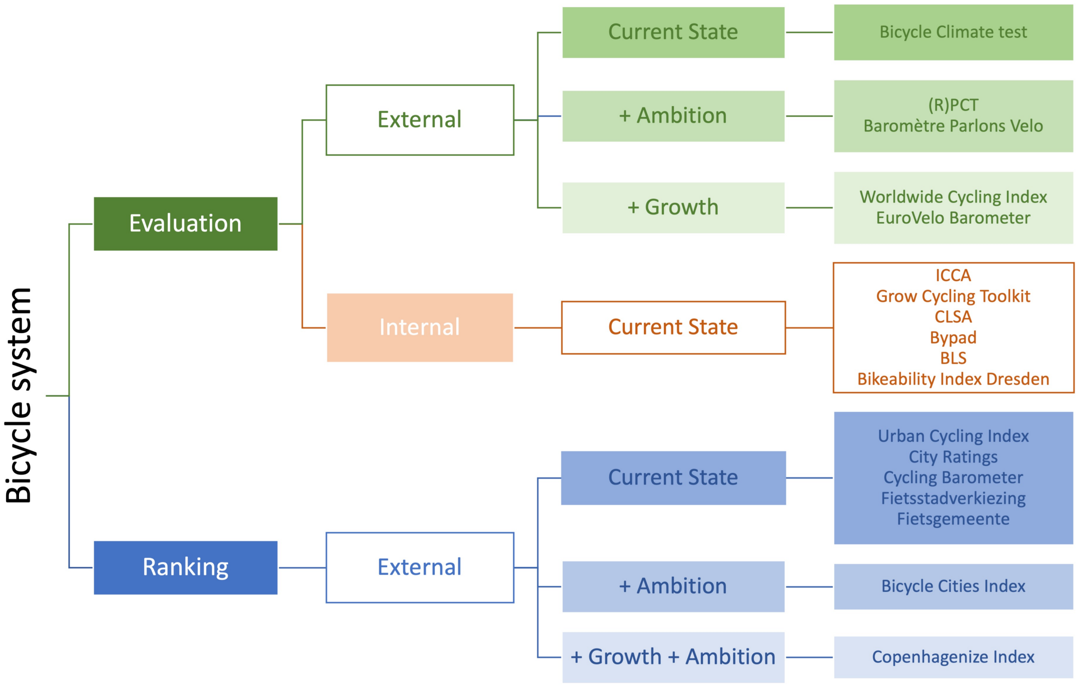


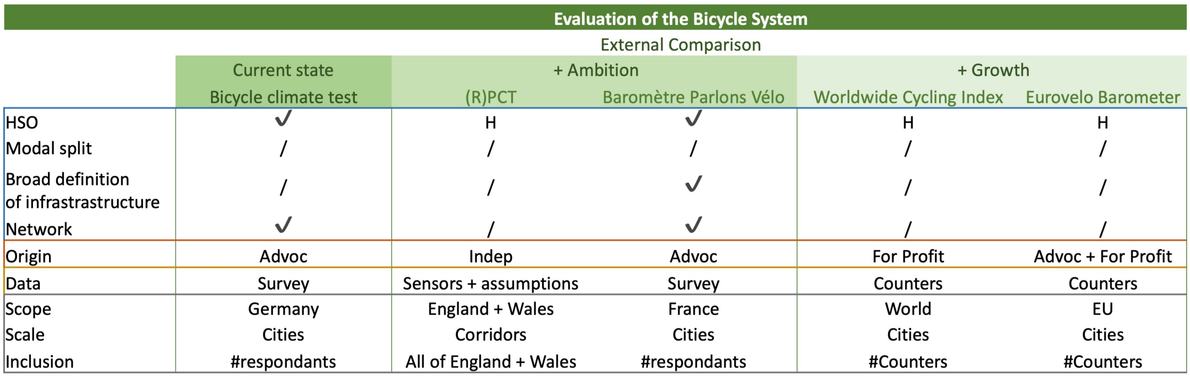
Figure 4.1: Typology of tools assessing the Bicycle System

4.2.2 Detailed Comparison

In order to further specify this general typology, a more detailed comparison will be made for the tools which seem to be comparable from this first level assessment and handle the bicycle system in general (figure 4.1). Attention will be given to:

- The parameters included in the analysis (HSO, modal split, broad definition of infrastructure, network)
- The origin of the tool
- The data that is used
- The scope and scale
- The inclusion criteria of certain areas in order to be evaluated

First, the external evaluation tools are analysed in more detail, figure 4.2 represents the results. Not that '/' is filled in, in case the tool does not include the given parameter, when it is not applicable or when it is unsure whether or not this aspect has been taken into consideration.



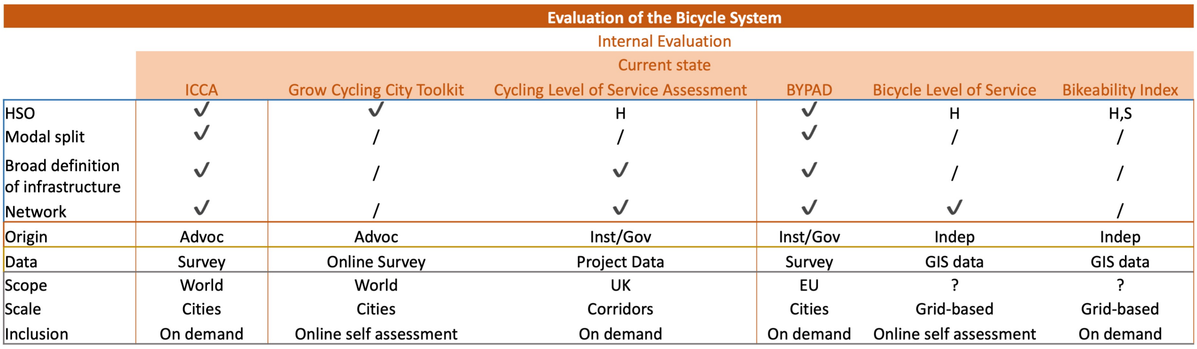
Evaluation of the Bicycle System

External Comparison

	Current state	+ Ambition		+ Growth	
	Bicycle climate test	(R)PCT	Baromètre Parlons Vélo	Worldwide Cycling Index	Eurovelo Barometer
HSO	✓	H	✓	H	H
Modal split	/	/	/	/	/
Broad definition of infrastrastructure	/	/	✓	/	/
Network	✓	/	✓	/	/
Origin	Advoc	Indep	Advoc	For Profit	Advoc + For Profit
Data	Survey	Sensors + assumptions	Survey	Counters	Counters
Scope	Germany	England + Wales	France	World	EU
Scale	Cities	Corridors	Cities	Cities	Cities
Inclusion	#respondants	All of England + Wales	#respondants	#Counters	#Counters

Figure 4.2: External evaluation tools

The same approach is followed for the internal evaluation tools, see figure 4.3. Even though several methods were categorised in the same way, it is clear that not all tools will yield similar results due to a different type of data that is being used, a different scope or scale or different parameters that are investigated.



Evaluation of the Bicycle System

Internal Evaluation

Current state

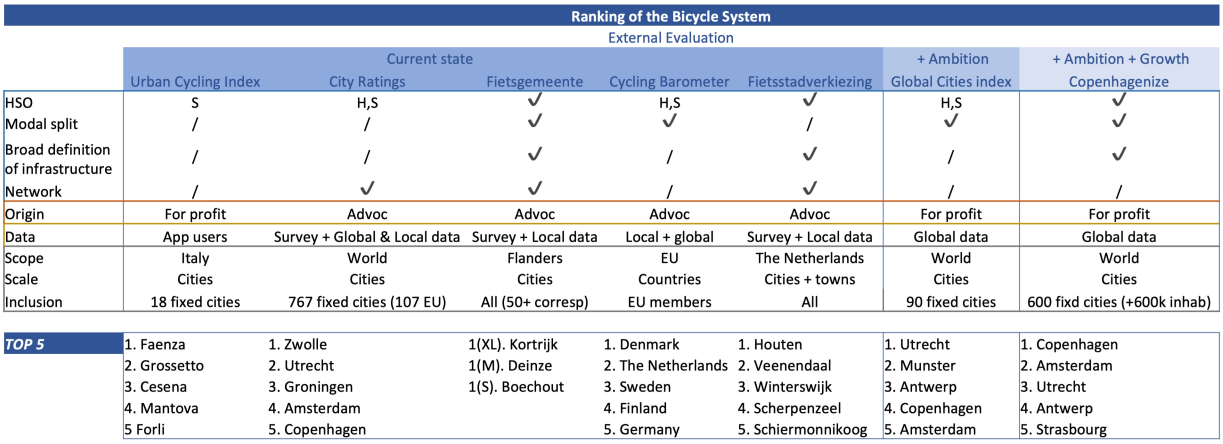
	ICCA	Grow Cycling City Toolkit	Cycling Level of Service Assessment	BYPAD	Bicycle Level of Service	Bikeability Index
HSO	✓	✓	H	✓	H	H,S
Modal split	✓	/	/	✓	/	/
Broad definition of infrastructure	✓	/	✓	✓	/	/
Network	✓	/	✓	✓	✓	/
Origin	Advoc	Advoc	Inst/Gov	Inst/Gov	Indep	Indep
Data	Survey	Online Survey	Project Data	Survey	GIS data	GIS data
Scope	World	World	UK	EU	?	?
Scale	Cities	Cities	Corridors	Cities	Grid-based	Grid-based
Inclusion	On demand	Online self assessment	On demand	On demand	Online self assessment	On demand

Figure 4.3: Internal evaluation tools

Lastly, figure 4.4 represents the results concerning the rankings of the bicycle system. Here, clear conclusions can be drawn about the fact that one should be careful when interpreting the different rankings.

A clear example is the case of the city of Antwerp, which seems to be highly ranked in the Copenhagenize Index and the Bicycle Cities Index. Due to this ranking, the city has been getting a lot of attention as being 'a top cycle city' that would be comparable with Amsterdam of Copenhagen [75]. Nevertheless, when looking closer into this situation, it is clear that the city's bicycle system is still lacking enormously behind Amsterdam and Copenhagen, for example in number of cyclists, safety or infrastructure. The reason that Antwerp is scoring this high in the two rankings consists of the fact that ambition and/or growth are mixed with the current situation. Strictly speaking, these three topics cannot be mixed into one ranking if one is aiming to make a meaningful comparison. The two aspects should be evaluated separately or the ranking should clearly specify what is being analysed.

Furthermore, inclusion criteria can have a large impact on the ranking. As different tools work with a fixed selection of cities, different outcomes might not be comparable even though similar scopes, scales and approaches were used.



Ranking of the Bicycle System

External Evaluation

	Current state					+ Ambition	+ Ambition + Growth
	Urban Cycling Index	City Ratings	Fietsgemeente	Cycling Barometer	Fietsstadverkiezing	Global Cities index	Copenhagenize
HSO	S	H,S	✓	H,S	✓	H,S	✓
Modal split	/	/	✓	✓	/	✓	✓
Broad definition of infrastructure	/	/	✓	/	✓	/	✓
Network	/	✓	✓	/	✓	/	/
Origin	For profit	Advoc	Advoc	Advoc	Advoc	For profit	For profit
Data	App users	Survey + Global & Local data	Survey + Local data	Local + global	Survey + Local data	Global data	Global data
Scope	Italy	World	Flanders	EU	The Netherlands	World	World
Scale	Cities	Cities	Cities	Countries	Cities + towns	Cities	Cities
Inclusion	18 fixed cities	767 fixed cities (107 EU)	All (50+ corresp)	EU members	All	90 fixed cities	600 fixd cities (+600k inhab)
TOP 5	1. Faenza 2. Grossetto 3. Cesena 4. Mantova 5 Forli	1. Zwolle 2. Utrecht 3. Groningen 4. Amsterdam 5. Copenhagen	1(XL). Kortrijk 1(M). Deinze 1(S). Boechout	1. Denmark 2. The Netherlands 3. Sweden 4. Finland 5. Germany	1. Houten 2. Veenendaal 3. Winterswijk 4. Scherpenzeel 5. Schiermonnikoog	1. Utrecht 2. Munster 3. Antwerp 4. Copenhagen 5. Amsterdam	1. Copenhagen 2. Amsterdam 3. Utrecht 4. Antwerp 5. Strasbourg

Figure 4.4: Ranking tools

Note that the full extent of the comparison that has been made is presented in Appendix A.

4.2.3 Identification of green and red 'flags'

Finally, an evaluation of the different tools is made based on several strong and weaker points which are being identified below as respectively red and green 'flags'. The evaluation of the tool was done by creating matrices and finally summing up the amount of strong and weaker points.

The strong points or positive signs that are being evaluated are listed below.

1. Inclusion of networks/accessibility
2. Inclusion of hardware, software and orgware elements and parameters
3. Inclusion of the modal split
4. Quantitative data included
5. Local data or sources are being used

As a result, matrix 4.10 is generated.

Green Flags	Network/ accessibility	Local data	Quantitative analysis	HSO	Modal split	Total
Worldwide Cycling Index		X	X			2
EuroVelo Barometer		X	X			2
Bicycle Climate Test	X			X		2
Baromètre Parlons Vélo				X		1
(Rapid) Propensity to Cycling	X	X	X			3
ICCA	X	X		X	X	4
Grow Cycling City Toolkit		X	X	X		3
Cycling Level of Service (TfL)	X	X				2
BYPAD tool	X	X		X	X	4
Bicycle Level of Service (Lowry)	X	X	X			3
Bikeability Index for Dresden			X			1
Copenhagenize Index				X	X	1
Global Cities Index					X	0
City Ratings	X	X	X			3
Cycling Barometer ECF		X	X		X	2
Fietsstadverkiezing	X	X	X	X		4
Urban Cycling Index						0
Fietsgemeente	X	X		X	X	4

Table 4.10: Stronger points of the qualitative cycling assessment tools

According to this table, not a single tool ticks all boxes. Nevertheless, observations can be made. First of all it is noted that two of the tools with the biggest amount of positive signs are rankings and two others are internal evaluations. Furthermore, three out these four tools do not satisfy the 'quantitative analysis' requirement. An important remark should be made out of this: it does not mean that the tool is less representative when a quantitative analysis is missing. The inclusion of this requirement was decided based on two reflections. The first one holds the fact that a calculation can hold a uniform and scientific way to assess and compare different bicycle systems. The second reflection consisted of the possibility to apply the respective quantitative assessments on a further case study in this master's thesis. Nevertheless, in this case, there was no such a possibility. Lastly, it is noted that the Fietsstadverkiezing by the Nederlandse Fietsersbond does not account for the modal split. On the contrary to the quantitative analysis, this is a 'defect' that could have considerable consequences. In this way, a city where nice facilities have been build and a lot of low speed zones for motorised traffic have been introduced, *but* where only 1% (e.g.) of the population is cycling, can be elected as cycle city of the year.

Next, the evaluation of the weaker points or red flags is performed based on the following warning signs that have been identified.

1. The tool has been developed by a company offering services related to cycling.
2. The concepts of current state and development or growth are mixed during the assessment.
3. No transparent calculation method is available.
4. Infrastructure is solely defined as cycleways, no broader definition is taken into account.

Table 4.11 represents the corresponding matrix.

Red Flags	Company offering services related to cycling	+ Ambition/ +Growth	No transparancy	No broad def of infrastructure	Total
Worldwide Cycling Index	X	X			2
EuroVelo Barometer	X	X			2
Baromètre Parlons Vélo		X			1
(Rapid) Propensity to Cycling				X	1
ICCA					0
Grow Cycling City Toolkit			X		1
Cycling Level of Service (TfL)				X	1
BYPAD tool			X		1
Bicycle Level of Service (Lowry)				X	1
Bikeability Index for Dresden				X	1
Copenhagenize Index	X	X	X		3
Global Cities Index	X	X		X	3
City Ratings					0
Cycling Barometer (ECF)					0
Fietsstadverkiezing					0
Urban Cycling Index	X			X	2
Fietsgemeente					0

Table 4.11: Weaker points of the qualitative cycling assessment tools

In light of this evaluation, it is important to note that the tools for which there was either uncertainty due to non-transparancy or the aspects were not applicable to the specific tool, no indication was given. This approach was implemented in order not to assign warning signs to tools that have a different field of application. For example, the goal of the Eco-Counter tool is to assess the popularity on different cycleways, as a result it would not fit into its scope to take the amount of available bicycle parking spaces into account.

According to table 4.11, the tools with the most warning signs are the Copenhagenize Index and the Global Cities Index. When comparing this to the amount of green flags, a similar result is found: respectively 1 and 0 are found. It can be concluded that the tools and their results should be reflected on carefully, by taking into account the warning signs that have been summed up. Note that this does not imply that the results are meaningless, only that careful consideration is suggested.

Finally, when both the green and red flag analyses are taken into account, the assessment tools of the bicycle system which are scoring the highest -have the largest amount of positive signs and have no red flags- are ICCA, Fietsgemeente and Fietsstadverkiezing. Bypad has one warning sign which corresponds to no transparancy, nevertheless this can be put into perspective as BYPAD also concerns a business model so it is understandable that not all aspects about the calculation are clear to the public.

4.3 Intermediate Conclusion and Experts' Insights

Twenty qualitative assessment tools have been summed up in the previous section and an attempt has been made in order to compare and analyse them. Two of them have been excluded from further analyses as they were outside the scope of this master's dissertation - more specifically the social cost-benefit analysis and the WHO heat tool that is used to define the benefits of the bicycle system.

The most surprising finding of the analysis was the fact that zero out of the eighteen remaining tools include all characteristics of the bicycle system -and its evaluation- that have been identified as most important: *HSO, the use of local data, networks and accessibility, the modal split, and a broad definition of infrastructure.* As a consequence, four tools have been indicated as the most encompassing ones without implying important warning signs: **ICCA, BYPAD, Fietsgemeente and Fietsstadverkiezing**.

The first two are BYPAD and ICCA. Both have been categorised as internal evaluation tools and lack a quantitative analysis. Nevertheless, as was mentioned, this does not have to outweigh the accuracy of the results. It is concluded that both tools are comprehensive methods in order to assess the current state of a bicycle system and in order to identify growing potentials. On top of this, the results of the analyses should be comparable. Note that the latter holds as far as the BYPAD method is transparent.
The other two tools are classified as rankings of the bicycle system. They originate from the Dutch and Flemish Fietsersbond - cycling advocacy and advisor organisations- and hold the election of 'cycle city' for respectively The Netherlands and Flanders. They are not comparable as their approaches are completely different and they focus on a different scope. The Flemish one concerns a detailed audit, while the Dutch one concerns a number of parameters that are either assessed by a quantitative calculation or by a survey. Furthermore, the modal split is not considered in the Dutch assessment. Joris Van Damme, one of the experts that has been interviewed, was chosen as a member of the jury of Fietsgemeente Vlaanderen. As he is familiar with the analysis, he confirmed the depth of the external audit, but also expressed concerns with respect to a focus which might be dedicated too much towards cycleway infrastructure. On the contrary, when discussing the conclusions derived from the green and red flag analysis, he complemented the parameter choice of the dutch election with their '50km/h zone'. It is agreed upon that the latter parameter reflects the real cycling climate, because this type of intervention increases safety in terms of space sharing as well as the modal split (in the long run). Even though these two concepts are interconnected, they cannot be considered interchangeable as they imply important characteristics and consequences on their own. The latter conclusion was confirmed by the other interviewed experts.

In addition, the parameter 'modal split' -and its exclusion from the Fietsstadverkiezing- turned out to be a hot topic in interpreting the qualitative assessments during the conducted interviews. The problem lies in the definition of 'a cycling city'. Is it defined as a city where the built cycling facilities correspond to the intensity of the local users, or is it defined as a city in which -maybe regardless of the cycling facilities and regardless of the discomfort caused by crowded infrastructure- a lot of people are cycling? As was established from the literary review, the bicycle system is not defined by its cycleways, and as a consequence the second definition should be used. This statement was confirmed by Joris and Kees. Furthermore, in performing their job as mobility planners, they prefer measures in terms of lowering the maximum speed of motorised traffic and space sharing, over the installation of new cycle paths. All of this following the famous quote "mix when you can and separate when necessary". In order to reflect these design considerations in the qualitative assessments, both the low speed zones and the modal split should be included. As an example, this is a topic where Amsterdam and Copenhagen are currently struggling with. Due to the continuous increase in modal split, their infrastructure is not sufficient anymore. Nevertheless, the modal split keeps on increasing. When on this behalf, also the increase of electric bicycles and cargo bicycles is considered, the latter point of discussion becomes more and more influential. Due to their different requirements with respect to safety or space, it is clear that these contemporary developments should be reflected in the qualitative assessments and that therefore the correct parameters have to be assessed.

The next striking outcome is the rather negative reflection of the Copenhagenize index. This is by far the most spread and known tool that is available, e.g. all experts were familiar with it. Nevertheless, they agreed on the remarks that were drawn. One the one hand, the subjectivity of the Copenhagenize Index came back several times during the interviews. One the other hand, the general consensus rose on the fact that the tool has been able to generate big incentives among cycling cities which is perceived as very positive to all stakeholders in the field.

To conclude, it is clear that not all qualitative assessment tools are representative with respect to the current establishment of bicycle systems over Europe. Furthermore, it is not possible to compare the results of different assessments due to the wide range of methodologies and the big difference in parameters that are assessed (ranging from 1 to 26) - except for ICCA and BYPAD. Thirdly, it is noted that none of the experts were familiar with all of the tools, but that they were satisfied with the overview and categorisation that have been provided.

Chapter 5

Spatial-Quantitative Assessment of the Bicycle System

Where the first part of this master's dissertation was focused on qualitative assessments of cycling, it became clear that a wide variety of tools is available and can be of great help when designing a bicycle system. Nevertheless, in order to obtain a well established bicycle system, appropriate spatial arrangements are crucial. This spatial-quantitative aspect was noted to be missing from the previously analysed assessments. Furthermore, during the literary review, it became clear that the importance of 'space' will only increase due to increasing demands. Nevertheless, this is not an easy task to fulfil as a lot of factors and stakeholders are to be considered. As a result, this section will zoom in on the issue regarding the design of cycleways - with an appropriate capacity and with enough resilience to overcome the projected increase of cyclists as well as their increasing variance. Note that, as was made clear in the analysis of qualitative assessments: cycling facilities and infrastructure are about more than only the cycleways itself; parking space, shelters, maintenance facilities, docking stations, etc. should also be considered. Unfortunately, they are outside the scope of this master's thesis as a detailed technical analysis is opted for the scope of a master's dissertation at the faculty of engineering. Consequently, the focus is put on the influence of the design and dimensioning of cycleways.

This chapter will first give an overview of available methods in order to allocate, share or distribute road space among cyclists or among traffic in general. The following list provides an overview on the topics that will be briefly discussed in light of this.

- Static Guidelines
- Cycling Behaviour
- Design Tools
- Dynamic Space Allocation

Secondly, two case studies are included. One concerns a street accommodating two way cycling on Haarlemmerdijk in Amsterdam, The Netherlands. The second one is the bicycle street on Coupure Links in Ghent, Belgium. The streets are analysed based on the spatial-quantitative tools that are discussed. Furthermore, their capacity will be compared to measured intensities and assumed multi-modalities. Based on a complete analysis, design options will be decided upon and recommendations will be made. The latter both with respect to the tools and to the case studies itself.

Concerning the case studies, the cities of Ghent and Amsterdam have been chosen based on different motivations. First of all, it was important to get the full picture of the cases: get all background information, get into contact with cooperating policy makers and to be able to perform a site visit. Professor Van der Bijl provided connections in Amsterdam and I was able to get into contact with experts from the home city of my university. Secondly, professor Van der Bijl and myself are frequent users of respectively Haarlemmerdijk and Coupure Links, which has increased the understanding of the bicycle system in the cities and corridors as well as enhanced this research. Lastly and most importantly, it is noted that the bicycle system of Ghent is assumed to be a representative case with respect to modal split, size, inhabitants and current developments in cycling for North-West Europe. Examples are Munich in Germany and Copenhagen in Denmark. The Netherlands on the other hand, have a much larger modal split. Furthermore, the country and in specific the city of Amsterdam is experiencing different issues with respect to the capacity and a diversity of cyclists that is incomparable to other cities. As was made clear from the literary review and the qualitative assessments, the city is perceived to be at the fore front of changes in the bicycle system. A more detailed explanation on the choice of the corridors themselves will be provided in the dedicated sections.

Finally, in the last part of this chapter, the experts' insights -with a focus on their in the field experience- will be used to complete a general conclusion regarding spatial-quantitative assessment of the bicycle system at this moment in time.

5.1 Concepts of Road Space Distribution/Sharing/Allocation

Similarly to the qualitative assessments of the bicycle system, an overview of the most common quantitative methods in order to assign road space to the bicycle system -in the form of cycleways- will be enlisted. Four categories have been distinguished; road space allocation based on static guidelines, based on cycling behaviour, based on tools and dynamic road space allocation. Note that not all of these methods are similarly practically applicable.

5.1.1 Space allocation based on Static Guidelines

The most prominent way in order to spatially design the bicycle system, holds the implementation of static design guidelines. Different countries hold different standards due to which it is not possible to give one general overview. Nevertheless, appendix B gives a good insight in different recommendations regarding cycling facilities [98]. The table originates from the objectives of the Multi-modal Optimisation for Roadspace in Europe. The project focused on five case study cities: Budapest, Constanta, Lisbon, London and Mälmo. As a result, the local recommendations have been expressed, but on top of this also the Dutch CROW guidelines, the German and the American NACTO guidelines were included. The latter were added due to their big influence in the world of cycling. When analysing this table, different general topics are distinguished.

- Basic space requirements for cyclists
- Buffer zone requirements to adjacent uses
- Application scopes of cycling infrastructure types
- Width of cycling space infrastructures
- Space sharing or separating cyclists with pedestrians or other traffic

Next, several CROW design guidelines, that are corresponding to the further analyses performed in this thesis, will be discussed in detail [91]. 'CROW is a Dutch non-profit organisation in which the government and businesses work together in pursuit of their common interests through the design, construction and management of roads and transport facilities' [22]. The organisation focuses on research, standardisation and knowledge transfer and management in traffic, transport and infrastructure. These specific guidelines were chosen to be elaborated because of several reasons. First of all, it was made clear that The Netherlands come to the fore front of current developments in the bicycle system and score high in qualitative rankings. Furthermore, their handbook "Dutch Design Manual for Bicycle Traffic" is one of the most influential manuals regarding the design of bicycle infrastructure (not just cycleways), over Europe and the world due to its high focus on comfort and safety. Therefore, a lot of manuals found inspiration in their extended provision of knowledge [35]. As this method of static design guidelines is used most used in practice, it is thus of great importance. Lastly, the guidelines were included because the subsequent part of this research will use a tool generated by CROW. This background is thus useful to understand the underlying principles of the CROW guidelines.

Basic space requirements for cyclists and buffer zones
First, the general width of a normal cyclist and the general width to cross obstacles are defined according to the manual. It is assumed that the general width of a cyclist with bicycle is equal to 750 mm.

Furthermore, minimum distances required from different obstacles from the central line of the of the bicycle are listed below.

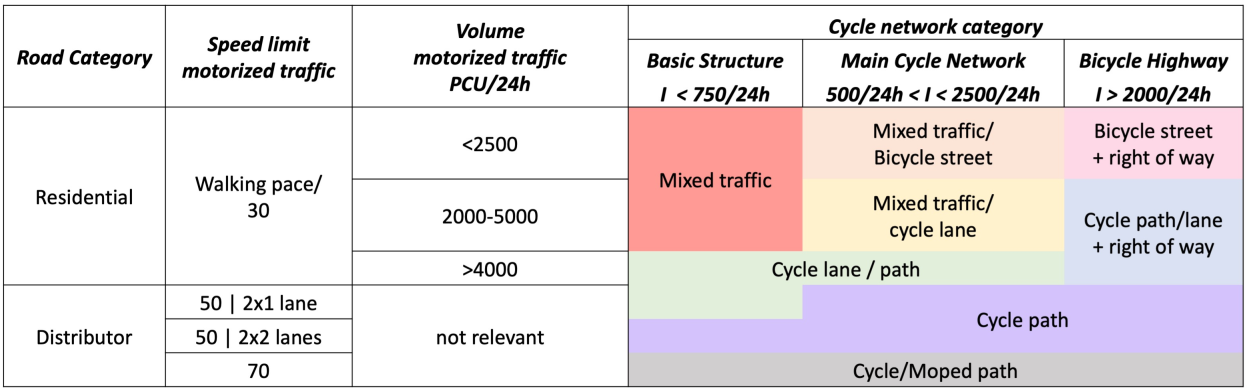
- 250 mm for a square edge lower than 50 mm
- 500 mm for a square edge higher than 50 mm
- 700 mm for fixed objects e.g. railings, traffic signs, trees
- 1000 mm for closed walls

With respect to the contours of the cyclists, other measures are adapted.

- 125 mm for a square edge higher than 50 mm
- 325 mm for fixed objects
- 625 mm for a closed wall

Application of cycling infrastructure types

Secondly, suggestions are being made on what type of cycling facility should be selected for different scopes. This is done based on the road category, the speed limit for motorised traffic, the volume of motorised traffic and finally the cycle network category. The latter is defined based on the intensity of cyclists: (1) basic network 750/24h, (2) main cycle network 500-2500/24h or (3) bicycle highway 2000/24h. A schematic representation of the recommendations is given in figure 5.1.



Road Category	*Speed limit motorized traffic*	*Volume motorized traffic PCU/24h*	*Cycle network category*		
			Basic Structure I < 750/24h	*Main Cycle Network 500/24h < I < 2500/24h*	*Bicycle Highway I > 2000/24h*
Residential	Walking pace/ 30	<2500	Mixed traffic	Mixed traffic/ Bicycle street	Bicycle street + right of way
		2000-5000		Mixed traffic/ cycle lane	Cycle path/lane + right of way
		>4000	Cycle lane / path		
Distributor	50 | 2x1 lane	not relevant		Cycle path	
	50 | 2x2 lanes				
	70		Cycle/Moped path		

Figure 5.1: Choice of cycling facility - CROW manual

Considerations concerning space sharing

Furthermore, the handbook holds specific guidelines for different types of lanes: a solitary/moped path, a bicycle highway, a centre line cycle path, a carriageway for space sharing, bicycle streets, a cycle lane, a segregated cycle/moped path, etc. It was chosen not to fully elaborate this part as it holds rather extensive elaborations for each of the cases.

Width of the cycling facility

In light of the current developments in the bicycle system and their big influence and pressure on the system e.g. the increase in bicycle usage as well as the increase in diversity e.g. the electrical and cargo bicycles, CROW has made recent adjustments to static guidelines concerning the width of cycling facilities. The manual has introduced labels according to the width of a cycleway, ranging from F to A. Here, F corresponds to way to small and A to perfect, i.e. the width of cycling highway according to their design rules. The suggested static guidelines corresponding to the manual refer to label B, in average situations. The general width-based label distinction for two-way and one-way cycleways is given in table 5.1. Note that the only distinction between one- and two-way paths, lies in label A [20]. Furthermore, a remark is made that after the performed analyses for this thesis, the recommendations for label C and B have changed (on the 21th of April) towards respectively 200cm and 230cm. Nevertheless, the analyses were not repeated as there was not a sufficient amount of time left.

Label	Two-way	One-way
A	400cm	300cm
B	220cm	220cm
C	220cm	220cm
D	170cm	170cm
E	120cm	120cm
F	0cm	0cm

Table 5.1: Width labels CROW

Apart from the minimal width of a cycling facility, the width label also corresponds to the amount of hindrance or dangerous encounters that are expected on the path. This depends on the intensity of the different vehicles that are present on the path. Finally the minimal value of the the two labels is assigned to the cycling path. The details of the approach will be explained in the section concerning tools.

An advantage of the introduction of this labelling system implies an opportunity to also include, categorise and prioritise the cycleways that do not fulfil the requirements (yet). Previously, this was not possible and these routes often got forgotten.

5.1.2 Space allocation based on cycling behaviour

The behaviour of cyclists differs substantially from the behaviour of motorists due to the limited restrictions. Nevertheless, this concerns a topic that is still unknown and research is still ongoing. The Allegro project, part of the European Horizon 2020 research and granted to Delft University in the Netherlands, aims to develop empirically underpinned behavioural theories, conceptual and mathematical models to explain or predict the dynamics of pedestrians and/or cyclists, All of this in an urban context [59]. Furthermore, the overall aim is to develop models for street space allocation based on these insights, rather then assuming a similar behaviour for all road users.

An example of the contrary can be found in figure 5.2. Here, the designers inherently assumed a similar behaviour of cyclists with respect to motorist vehicles by introducing this 'centre rush hour lane'. The question remains whether this is compatible with general cycling behaviour.

Figure 5.2: Lane Reverse China [6]

For the practical design of (inter)sections, this behavioural-oriented approach has already been implemented in the sense of 'Desire Lines' [17]. Practically, this holds filming a specific location, observing the cycling behaviour and recording the results - or use AI to get the results. In the final analysis, a design is proposed that takes into account the real life cycling behaviour. Figure 5.3(a) represents an example of this type of analysis performed by Copenhagenize in Værnedamsvej, Copenhagen. The results of these analyses can entail small interventions like removing an isle or finding another location for a sign or a whole new design. As an example, also the city of Amsterdam has improved the design of several intersections according to this method.

Lastly, an example from Singapore's 'Gardens by the Bay' park will be highlighted [24]. The design holds a space sharing for cyclists, pedestrians and golf carts. It is an inspiring example of designing by taking into account behavioural aspects, as according to Joris Van Damme, the road space is distributed according to the speed of its users. On the left, behind the trees, a separated part is dedicated to pedestrians who want to slender, rest on a bench, take pictures etc. i.e. the '0 km/h zone'. Next to it, there is a zone dedicated to fast pedestrians, joggers and slow cyclists. In the middle there is space for the golf carts and fast bicycles. This implies that you can chose a lane depending on your speed. Furthermore, the yellow lines are to be crossed easily as they are meant to be a 'soft boundary'. The latter on the contrary to the 'hard boundary' that is formed by the lane of trees in order to protect the pedestrians.

(a) Desire lines by Copenhagenize in Værnedamsvej, Copenhagen [17]

(b) Space sharing Gardens by the Bay park, Singapore [24]

Figure 5.3: Designing based on Cycling Behaviour: example

5.1.3 Space allocation based on Tools

Over the years, several institutions and organisations have developed tools in order to quantify (or check) an appropriate road space allocation to the bicycle system. The tools that will be discussed are the 'width-tool' and 'meeting forecaster' by CROW, the 'new cycle route quality criteria' by TfL and the 'streetspace allocation option generation' tools for interventions and design by MORE.

5.1.3.1 CROW Width-tool Cycleways: Determination Class Width

The CROW width-tool for cycleways is an extension of the introduction of width-labels by CROW. Based on predefined minimal width requirements and an analysis of hindrances and dangerous encounters, a width label is assigned to cycleways corresponding to their capacity. The tool originates from a collaboration between CROW and DTV consultants [6].

Practically, the model is based on an analysis of the same 15 cycle lanes in The Netherlands that had been analysed in 1989 by TU Delft and that have led to the original CROW manual [20]. The approach holds a quantitative and qualitative part. On the one hand it calculates the amount of hindrance or dangerous encounters, while on the other hand a survey was conducted. The survey was performed on users of the 15 cycleways and it resulted in a weighting system for the calculation of the width class. An important finding holds the fact that encounters with mopeds are corrected with a factor 5 as they are perceived to cause a lot more hindrance than encounters between cyclists.

Finally, the two pillars of the determination of the width classes are:

1. The minimal width that a cyclist (or a combination of cyclists) needs, regardless of the intensity. Table 5.1 sums up the corresponding requirements. (Note again, that in the mean time these requirements have changed.)
2. The maximum amount of hindrances and dangerous encounters.
   The latter takes into account:
   - The percentage of mopeds, duo cyclists and wide bicycles
   - Direction differences
   - Speed differences
   - The effective cycle path width
   - Choice of the correct benchmark moment for the design (e.g. morning rush, busy summer weekend, etc.)

In the case of general situations and low to average intensities, the given fist rules of table 5.1 should satisfy the requirements. Nevertheless, in the case of a high intensity, complex situation, a high share of fast or big vehicles, etc., it is advised to use the 'Width Tool for Cycle Lanes' which was provided in Excel. The tool can also be used to perform sensitivity analysis. An important note holds that the tool is based on the assumption that cyclists use the space effectively and what it was designed for, e.g. minimum distance from each other and obstacles.

The following inputs are required:

- The intensity of cyclists per hour
- The share of intensities in each direction
- The percentage of duo cyclists, wide bicycles, mopeds
- The width of the cycleway
- The width of the obstacle free zones on the right and the left
- If the sidewalk step is higher than 5cm or not, on the right and on the left
- Settings concerning the speed profile of bicycles and mopeds
- Aimed degree of satisfaction

The output of the tool consists of the width class label accompanied by a theoretical table which holds the widths that are necessary for the cycleway to be contained in the different classes. The minimum of the width label and the hindrances label is assigned. Lastly, the limiting label is mentioned.

5.1.3.2 TFL: New Cycle Route Quality Criteria

Based on the London Cycling Design Standards best practice guide, Transport for London has generated the 'New Cycle Route Quality Criteria'. The latter is accompanied with a numerical Excel-based tool generating:

1. The suitability for routes to consist of space sharing between cyclists and motorists
2. A recommendation concerning the appropriateness for the design solution in the given context of needed provision

The tool consists of two parts, on the one hand it assesses the existing conditions, on the other hand it checks a proposed design. In order to obtain results, the user has to insert data for each corresponding link of a cycling route. A link is defined as an element that compromises one consistent street character (no junctions). The data that is required in order to perform the assessment is the following:

- Existing motor vehicle flows
- Heavy goods vehicle peak flow (or HGV, lorries and trucks over 3.5 tonnes)
- Classified turning counts at major junctions on the routes
- 85th percentile speed data for a typical weekday
- Carriageway dimensions
- Kerbside bay width where loading and parking is permitted

Given this information, the tool will generate 'green' or 'grey' levels, respectively corresponding to routes obtaining the target level of provision for new cycle routes and routes obtaining the required level.

The six criteria that are used, will be summed below [43].

1. The **degree of separation** for people cycling is appropriate for the total volume of two-way motorised traffic
   (a) *Green*: Mixed if less then 500 motor vehicles per hour (vph), preferably less than 200vph
   (b) *Grey*: Segregated cycle lane as absolute minimum for more than 100vph
2. The **speed of motorised traffic** is appropriate for people cycling
   (a) *Green*: Mixed if 85th percentile speed is less than 25mph
   (b) *Grey*: Not mixed if 85th percentile speed is more than 30mph
3. An appropriate **width for cycling** is provided to suit the local context
   (a) *Green (Mixed)*: Minimum width equal to:
      - 3.2m for $<$ 500vph, 85th percentile speed 25mph, proportion HGV $<$ 5 %
      - 4.5m if conditions are not met
   (b) *Green (Separated)*: Minimum width equal to:
      - 2.2m for one-way cycle lanes
      - 3m for two-way cycle lanes

(c) *Grey*: absolute minimum

- 1.5m for one-way cycle lanes
- 2m for two-way cycle lanes

4. **Collision risk** between people cycling and turning motor vehicles is minimised

   (a) *Green*:

   - Priority junctions: speed and/or volume reducing infrastructure measures
   - Signal controlled junctions with full separation: dedicated signals for cycles

   (b) *Grey*: signal controlled junctions: cycle early release signal

5. **Kerbside activity** had a minimal impact on people cycling

   (a) *Green*:

   - Remaining lane width > 2m: 85th speed percentile > 25mph
   - Remaining lane width > 2m: 85th speed percentile 25mph, two-way vehicle flow > 200vph, proportion HGV > 5%

   (b) *Grey*: Separate cycle lanes should be physically separated and allow at least 1m clearance from parked motor vehicles.

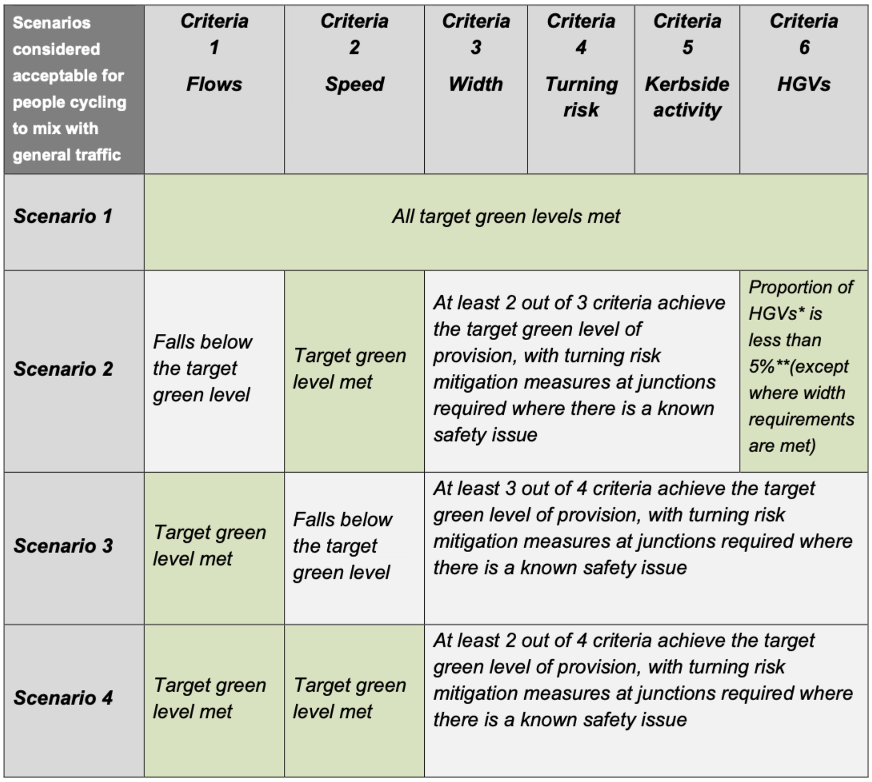
6. **Interaction between HGVs and people cycling** in mixed traffic is minimised along a link

   (a) *Green*:

   - Two-way vehicle flow 200vph: HGV > 10%
   - 200vph > two-way vehicle flow > 500vph: HGV >5%

   (b) *Grey*: Specific measures should be taken to reduce HGV flows and/or people cycling on new routes.

Not all green target levels have to be reached in order for a scheme to be accepted as appropriate. Three extra scenario's are considered and accepted, see figure 5.4.



Scenarios considered acceptable for people cycling to mix with general traffic	Criteria 1 Flows	Criteria 2 Speed	Criteria 3 Width	Criteria 4 Turning risk	Criteria 5 Kerbside activity	Criteria 6 HGVs
Scenario 1	*All target green levels met*					
Scenario 2	*Falls below the target green level*	*Target green level met*	*At least 2 out of 3 criteria achieve the target green level of provision, with turning risk mitigation measures at junctions required where there is a known safety issue*			*Proportion of HGVs* is less than 5%**(except where width requirements are met)*
Scenario 3	*Target green level met*	*Falls below the target green level*	*At least 3 out of 4 criteria achieve the target green level of provision, with turning risk mitigation measures at junctions required where there is a known safety issue*			
Scenario 4	*Target green level met*	*Target green level met*	*At least 2 out of 4 criteria achieve the target green level of provision, with turning risk mitigation measures at junctions required where there is a known safety issue*			

Figure 5.4: Acceptable scenario's for general traffic to be mixed with cyclists [43]

5.1.3.3 Streetspace Allocation Option Generation Tools by MORE

MORE or Multi-modal Optimisation for Road-space in Europe is a EU-funded collaboration between 18 partners aiming to develop and implement procedures for the design of urban corridor roads. The research is concentrated on five cities of the Trans European Transport Network (TEN-T): Budapest, Constanta, Lisbon, London and Malmö. One of the deliverables are the considered streetspace allocation option generation tools aiming to assist planners and the public to explore feasible solutions for streetspace allocation taking into account the needs of all street users and local policy objectives [3]. It is accessible online to everyone [2]. More specifically, two tools were generated: one regards street space interventions, the other one street designs. Practically, the tools combine existing methods, databases about previous interventions, technical reports and academic studies on one single street or policy objective in order to get a better understanding. Furthermore, standardised information about the likely effect on street users and policy objectives is used.

An important first note is that the street widths and the capacity of design elements are based on the NACTO Global Street Design Guide [60]. Secondly, it is important to note that the tools are limited due its predefined range of street widths that can be analysed.

(A) Streetspace Interventions Tool
Lying underneath the streetspace intervention tool is a database with 210 possible interventions, the full list is available online and holds standardised information. In order to perform an analysis and propose interventions, different inputs are asked from the users. They are briefly summed below:

1. The level of priority for each type of street use -both use for movement and place- and the corresponding user should be chosen between level 0 and level 2.

- Pedestrians (walk, cross the street, stroll, sit)
- Pedestrians with restricted mobility (walk, cross the street)
- Cyclists (move, park, rent (dock + dockless)
- Micro-mobility users (move)
- Bus drivers (move, stop)
- Bus passengers (interchange, wait)
- Rail/metro/bus passengers (interchange)
- Car Drivers (move, park, stop)
- Car Share Users (move)
- Motorcyclists (move)
- Taxi Drivers (wait)
- Taxi Passengers (wait)
- Goods Vehicles (move, stop)
- Emergency Vehicles (move)
- Service Vehicles (move)

2. The five main objectives that are aimed by the project, in terms of street users (movement and place), economy, society and environment. They should be chosen from a list and coincide with the cities' sustainable urban mobility plans. In detail, the categories are summed below. Note that they coincide with the E's from the E5model.
    - Movement
    - Place
    - Street operation
    - Economic objectives
    - Social objectives
    - Environmental objectives

The tool returns a list of all possible streetspace interventions that coincide with the objectives and priorities that have been defined in the inputs. It concerns streetspace designs, reallocation suggestions and regulations that are accompanied with more detailed information about each option. A description is provided, accompanied by an image of what the situation could look like and by examples and/or evidence from similar past projects. Furthermore, the likely effects on street uses and the effect on policy objectives are listed.

(B) Street Design Tool
For the generation of street design options, a big database of 30300 possible interventions is used for urban streets with widths from 15 to 35 metres. Each street design is composed of a series of elements (e.g. walking, cycling, green area, etc.). Furthermore, each element can be placed in various positions of the street and can hold different widths. The latter were extracted from another MORE project: Urban Corridor Road Design and were complemented with information from the National Association of City Transportation Officials (NACTO) and

the Global Designing Cities Initiative (GDCI). A summation is given below.

- Walking
    - Narrow: 2m
    - Medium: 3m
    - Wide: 4m
- Place Activities
    - Narrow: 2m
    - Wide: 3m
- Green Area: 1.5m
- General Purpose (defined as motorised car traffic)
    - 1 lane: 3m
    - 2 lanes: 6m
- Bus lane
    - 1 lane: 3m
    - 2 lanes: 6m
- Cycling
    - 1 lane: 2-3m
    - 2 lanes: 3-4.5m
- Bus + Cycling: 4m
- Parking/Loading: 2.5m
- Tram Line
    - 1 track: 3m
    - 2 tracks: 6m

Furthermore, the database holds statistics concerning the estimated street capacity for movement as well as people- and vehicle-based activities.

As input of the tools, the current situation has to be assessed in terms of the widths that are currently assigned to different street uses. Next, the levels of priority have to be decided again for the uses.

Finally, the tool generates a list of possible street designs fulfilling the given criteria together with the estimated capacity for movement and collective capacity (people/hour of all types of street users). The solutions are presented visually according to a division between the left footway/kerbside, left carriageway, median strip, right carriageway, right footway/kerbside. All zones get a dedicated use accompanied by the possible standard widths that have been listed above.

5.1.4 Dynamic road space allocation

The last type or road space allocation that will be discussed is the dynamic one. In general, the space needed for street users varies depending on the time of the day, week, year, season, etc. In order to provide an efficient solution to this, historically different options have been explored based on traffic signs and road markings. Two of the most popular are listed below.

1. Allowing space to be used by multiple users, at the same time, possibly for different durations.
2. Varying space allocation by time of day.

Nevertheless, these methods hold limitations concerning the amount of information that can be shared with the road users and concerning the ability to vary this in a dynamic, real time frame. These points of attention could be addressed by using the FlexKerb principle developed by Arup in Britain [4]. An example entails the practical application by LED markings. The latter was a part of the 'Assessment of potential for new technologies' by the MORE project of 2022, more specifically trials were performed in laboratory conditions [9]. Apart from motorised traffic, the study also included cycle lane transitions and pedestrian crossing, see example on figure 5.5. (Note that next to this advanced technology that is on trial, currently smart traffic lights can be used for this application of dynamic road space application.)

Figure 5.5: FlexKerb concept pedestrian crossing

In general, the aim of FlexKerbs is to transform fixed kerbsides into dynamic, technologically advanced spaces that change function throughout the day and week in response to local demands. Furthermore, it has been studied that FlexKerbs would:

- Be technologically feasible
- Balance the needs of all road users
- Give cities proactive agency in achieving local objectives
- Enable efficient use of street space
- Effectively allocate kerb space to enhance public realm while maintaining traffic flow.

Even though the concept of dynamic road space allocation seems promising, there are still a lot of challenges and questions concerning FlexKerbs and other forms of this concept. Among which are physical infrastructure, access to disabled people, law enforcement and regime, cybersecurity, government regulations, funding, etc..

Note that figure 5.2 concerning the reverse cycle lane during rush hour concerns another example of dynamic road space allocation.

5.2 Case Studies on Streetspace Allocation

After a brief analysis on different concepts on how to allocate road space, case studies have been performed in order to check the applicability of the tools and methods that have been summed up. In addition, specific designs will be compared, the issue of capacity will be discussed and the resilience towards contemporary developments is checked.

More specifically, two cases will be considered, one is the Coupure Links in Ghent, Belgium and the other one concerns Haarlemmerdijk in Amsterdam, The Netherlands. Both cases are very different, as the first one holds a general bicycle street with one way car traffic and the second one holds a street accommodating two-way cycling. Furthermore, both are located in completely different bicycle systems and as a result, are prone to very different conditions and challenges. (Note that the choice of these two bicycle systems in the specific cities and countries has been discussed more elaborately in the introduction of chapter 5.)

All tools that have been explained, will be applied. Nevertheless, the focus will be on the CROW width-label tool for cycleways as it allows to perform very detailed sensitivity analyses with respect to different road user compositions and intensities. Therefore, some general considerations and assumptions in applying the tool are provided below. These are valid for both case studies.

Considerations in applying the CROW width label tool

Strictly speaking, the CROW width tool was designed for separate cycle paths, without car traffic. Nevertheless, it was chosen to adopt the tool anyway for both cases as the intensity of motorised vehicles is very low. When interpreting the results, this will be an important factor.

Practically, the tool will be used to analyse and compare the capacity of different design options. Furthermore, the sensitivity and resilience analysis towards a change in 'composition' of type of users will be made for the two cases.

Assumptions
During the entire analysis, assumptions were made concerning the amount of wide bicycles, mopeds and duocyclists. As the available data makes no distinction between these categories, the average values found in the investigation of CROW and DTV were used [6] [20]. They are summed below. Even though these values were adapted as a standard during the analysis, note that the influence of a higher and/or lower share will be investigated.

- 4% of mopeds
- 1% of wide bicycles
- 14% of duocyclists

Furthermore, assumptions are made concerning the amount of cyclists cycling in the main direction during rush hour.

- 100% in the case of a one-way cycleway
- 66% for two-way cycleways

Another important assumption is the speed distribution of cyclists. The latter was also assumed to be equal to the average findings of the investigation of DTV and CROW. Table 5.2 represents this distribution, which is divided in classes of 5 km/h.

Speed Class [km/h]	Investigation DTV
0-5	0 %
5-10	0.2 %
10-15	14.9 %
15-20	47.4 %
20-25	28.9 %
25-30	7.3%
30-35	1.1 %
35-40	0.2 %
40-45	0%
45-50	0 %
50+	0 %

Table 5.2: Assumed Cycling Speed Profile

Concerning the speed distribution of mopeds, table 5.3 is assumed. This results from the same investigation of CROW and DTV.

Speed Class [km/h]	Frequency [%] (Investigation DTV)
0-5	0 %
5-10	0 %
10-15	0.9 %
15-20	5.9 %
20-25	14.3 %
25-30	19.4%
30-35	18.8 %
35-40	14.8 %
40-45	10.3%
45-50	6.5 %
50+	9.1 %

Table 5.3: Assumed Moped Speed Profile

Approach

First, the static width label of each design will be determined. This is done by comparing the effective width B_{eff} of the cycle path to the values that are summed in table 5.1. This effective width is determined by taking into account the free space on both sides of the cycle path and making the difference to the required 50cm. Furthermore, a correction of 20cm is provided in case the kerbs are higher than 5cm.

Next, the quantitative analyses are performed by using the CROW-tool. This is done only on the hindrances label as the width label concerns a static one. In this case, the A-F labels are transformed respectively to 5-0 labels. Meaning 5 corresponds to the best situation and 0 to the worst. Four different parameters are analysed in function of the cycling intensity (the share of cyclists in one direction, the share of duocyclists, wide bicycles and mopeds).

Note that a maximum share of 40% was accounted for concerning the different type of cyclists. This was decided based on the individual results of the DTV and CROW investigations on cycle paths [6]. More than 40 % of one specificity is unlikely. Furthermore, this value still holds a certain possible slack.

Finally, the sensitivity analyses on the hindrances width-label can be performed in terms of the intensity. This happens for the parameters and respective ranges that are summed below.

1. The share of duocyclists - 0% to 40 %
2. The share of wide bicycles - 0% to 40 %
3. The share of mopeds - 0% to 40%
4. The share in the main direction - 50% to 100%

It was chosen to increase the hourly intensity by steps of 50 bicycles/hour until the hindrances width labels for all ranges of the investigated parameter are equal to zero, with a maximum of 4000 bicycles/hour. Note that this discrete approach implies that, practically, if an observation yields a result of X capacity, the actual capacity will be in the interval of $[X, X + 50[$. Furthermore, 25 bicycles/hour is used as a starting value because it can be meaningful to use a small intensity in the case of very small/ obstructed or highly stressed bicycle paths. Smaller values are not considered as this intensity already corresponds to less than one cyclist per 2 minutes. Values that are lower are not representative for the case studies that are considered.

The results will be represented in a matrix defined by the hourly intensity and the investigated parameters. A range of 5-0 will indicate the hindrances width label. In order to make the results visually more understandable, colours have been assigned to each number.

Note that the final width label is the minimum of the static width label and the hindrances width label. And thus, the label inside the matrices does not correspond to the final width label.

Definition of capacity
Apart from sensitivity analysis, the capacity will be defined or all of the considered cases. This is done based on the average cycling composition of the DTV and CROW composition as well as by taking into account other relevant compositions. The definition of this capacity will follow the the assumptions of the tool. The reasoning is explained below.

As was mentioned during the introduction of the tool, the guidelines of CROW correspond to label B. As a consequence, it is assumed that the transition from label B (4) to label C (3) corresponds to the capacity. A very important note holds the fact that if the static width label -corresponding to 5.1- does not fulfil A or B, the capacity is implicitly equal to zero regardless of the hindrances label, and is thus independent of the composition of the users. This application and interpretation of the capacity in using the tool was checked and confirmed by Otto Van Boggelen, who is a representative of CROW and lies at the origin of the tool.

Note that this definition of capacity is not similarly defined as the capacity of motorised car traffic. In the latter case, the capacity will be defined based on the amount of cars that are needed to completely block the road. In the CROW notion of cycling, on the contrary, a bigger focus is on the experience. It can be described as a 'spatial-qualitative' definition. This line of thinking becomes more clear when looking at table 5.4 which classifies the chances of dangerous encounters and hindrances in the different labels [6]. This result was found by taking into account the 'score' of the public.

Label	Chance of dangerous encounters
A-5	Very small
B-4	Small
C-3	A little too big
D-2	Big
E-1	Very big
F-0	Extremely big

Table 5.4: Width labels CROW and corresponding hindrances chance

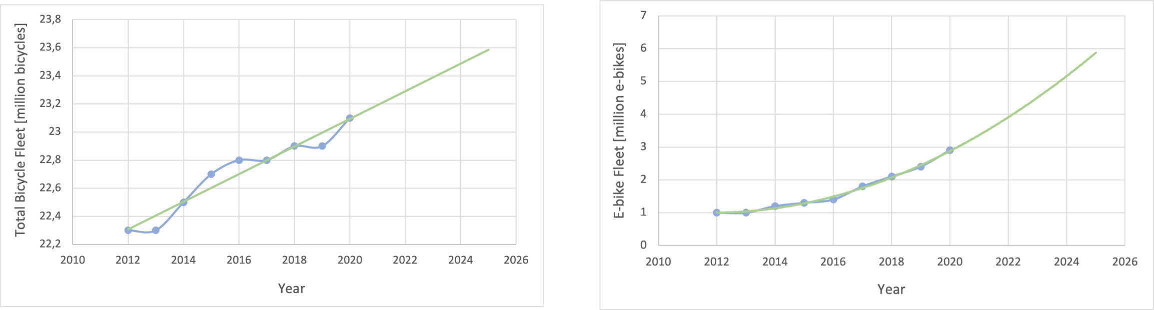
Finally, in comparing this theoretically defined capacity to real life, the measurements coinciding with the rush hour are assumed.

The Influence of Contemporary Developments

As was concluded from the literary review, the increase of wide bicycles and e-bikes, puts a certain pressure on the bicycle system and has an influence on the capacity of cycleways.

As a consequence, it was opted to quantify this reduction in capacity based on the increasing shares of wide bicycles and faster e-bikes. The sensitivity with respect to the wide bicycles can directly be read from the performed analyses. But in order to quantify the change in capacity due to an increased share of fast bicycles, another approach is necessary: the speed profile of the bicycle will be adapted.

Within the tool, the speed profile of table 5.2 is assumed for all bicycles combined. Nevertheless, this can be adapted. The latter was done based on data of RAI, Rijwiel en Automobiel Industrie. The Dutch association represents the interests of over 700 manufacturers and importers of passenger cars and trucks, trailers and semi-trailers, bodywork and special vehicles, motorcycles and scooters, mopeds and bicycles. As a result, they published a report 'mobility in numbers for two-wheelers 2021-2022 [74]. Here, a quantification of the Dutch bicycle fleet is represented as well as a quantification of the e-bike fleet. Based on these numbers of the previous years, a trend line was calculated due to which an estimation for 2025 could be made for both, the total bicycle and the e-bike fleet. Respectively 23.52 and 4.67 million were found. Figure 5.6 graphically represents the assumed trends in green. The data is provided in blue. Note that only a prediction of five years in advance was made as there is not enough data available in order to make a representative prediction for 2030.



(a) Total Bicycle Fleet

(b) E-bike fleet

Figure 5.6: Bicycle fleets in The Netherlands [74]

Subsequently, the increase of ratio of the e-bike fleet over the total fleet, was assumed to be related to the general speed profile of bicycles from table 5.2. More specifically, the increase of this ratio is assumed to decrease the share of traditional bicycles in the same amount as it will increase the share of electrical bikes with respect to the speed profile. As a result, the speed classes have been assigned to a certain type of bicycle, see table 5.5.

0-5	Traditional bicycle
5-10	
10-15	
15-20	
20-25	E-bike Type 1
25-30	
30-35	E-bike Type 2
35-40	
40-45	
50+	

Table 5.5: Influence on speed profile dedicated to certain types of bicycles

Note that it is not assumed that the mentioned bicycles can only ride in these speed classes, but that an increase of the share of certain types of bicycles will result in an increase of the frequency of the speed classes. Furthermore, the data of RAI refers to e-bikes as a combination of the different types of e-bikes such as speedpedelecs and fatbikes, which ultimately go faster than a general urban e-bike. Therefore, it was opted to include a differentiation between 'type 1 and 2' of the e-bikes. They correspond to bicycles which solely have pedalling assistance and the ones which have a gas handle. Furthermore, common urban e-bikes can also be 'hacked' in order to increase the speed limit. Also these bicycles are categorised under type 2.

Concerning the ratio of the total increase of e-bikes over total fleet, essentially three different assumptions have been made for the calculation in the year 2025. They are summed below.

1. A yearly increase with a factor equal to the increase of e-bikes over the increase of the total bicycle fleet. - *purple*
2. A constant yearly increase of 2.07% of the ratio e-bike fleet over total fleet, i.e. similar to the data difference between 2019 and 2020. - *blue*
3. An increase based on the direct determination of the ratio in 2025 by using the trend lines. - *green*

Within the assumed zones of increasing (e-bike) and decreasing (traditional bike) frequencies, the changes with respect to a specific speed class, are determined according to the ratio of the original frequency -of the DTV investigation- with respect to the sum of the original frequencies of all width classes within the increasing or decreasing zone.

When this approach is followed, the corresponding speed profiles of 2025 can be generated for the four assumptions. The results are graphically represented in figures 5.7 and 5.8. They show a wider, more flat distribution which is shifted towards the right. This implies that the speed on cycleways will on average be larger, but also that more speed differences will occur. This is in line with the general expectations. Furthermore, it is noted that the green and blue distributions are similar and the purple one represents a slightly different behaviour.

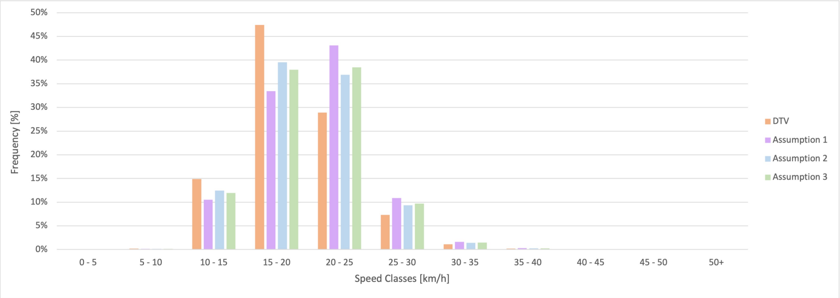


Figure 5.7: Calculated average speed profiles 2015 - Bar Plot

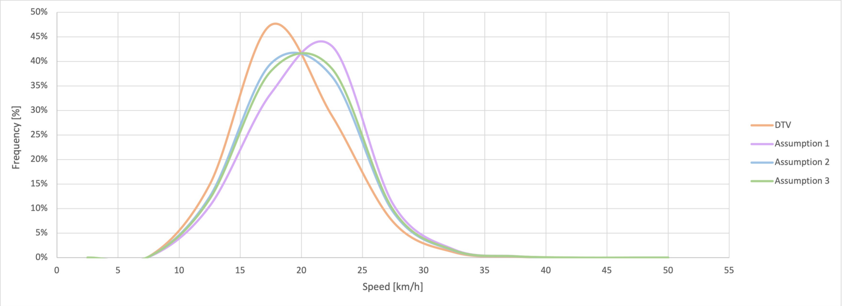


Figure 5.8: Calculated speed profiles 2015

Finally, the obtained profiles can now be used in the simulations of the CROW width-tool in order to assess the capacity, under one of the assumptions with respect to the increasing amount of e-bikes.

Note that this is a very general approach to the problem, by making use of average values accounted for in The Netherlands. In order to be correct, specific data of the specific case studies should be applied into the tool. Furthermore, it should be noted that this holds a very intuitive approach in order to check the influence on a changing speed profile in the CROW width tool. As a result, it should not be considered as an actual prediction of the future speed distribution. Its solely purpose is to check the change in capacity by a change of the speed profile within the tool.

5.2.1 Case study - Coupure Links, Ghent

The Coupure Links is an important corridor that forms the connection between the neighbouring municipality Mariakerke and the city centre of Ghent. It concerns a one-way street on the left side of the homonymous water stream the Coupure. On both sides of the water, there is a lot of green and high trees, which makes it attractive for people to cycle. Furthermore, the alternatives next to the Coupure Links to cycle, in the same direction, consist either of the busy ring road or roads through the city centre. Also a university campus is located on the street, which makes the street an important destination as well.

Originally, a cycle lane was provided behind the trees, near the waterfront (see figure 5.9(b)). This cycle lane was for one-way use. The street solely belonged to motorised traffic. Pedestrians had to walk on the pavement near the side of the houses. Nevertheless, in the mean time, interventions have been performed with the result that the Coupure Links is currently a bicycle street (figure 5.9(a)). This has happened in two cycles in 2018 and 2019, due to which the Coupure Links officially became the longest bicycle street of Ghent with a length of 1.3 km [15].

The traffic rules in the street allow cyclists to use the bicycle street in two directions while cars are only allowed in one direction. The latter direction depends on the location of the street and thus changes over the length. Mopeds are allowed on the street and the speed limit is equal to 30 km/h for all users.

All of these aspects make the Coupure Links an worthy case to study due to its high user intensity, attractiveness and recent development. Furthermore, several datasets are available with respect to the amount of bicycles, cars and heavy vehicles. On top of this, a bicycle counting device was placed in the street. The corresponding data was made available by Stad Ghent.

(a) Current Bicycle Street [79]

(b) Previous Cycle Path [116]

Figure 5.9: Coupure Links, Ghent

An average intersection was taken in order to perform the different analyses. This was done based on plans that are available on the website of Stad Gent [51]. Figure 5.10 represents a simplified version of the section. Starting from right to left, one can distinguish the different zones that are summed below. The total width of the road complex corresponds to 13.6 m.

- 2.5m of current pedestrian area (the previous cycle path)
- 2.6m of green zone
- 4.3m bicycle street
- 2m of parking space

- 20cm of gutter
- 2m of pedestrian area

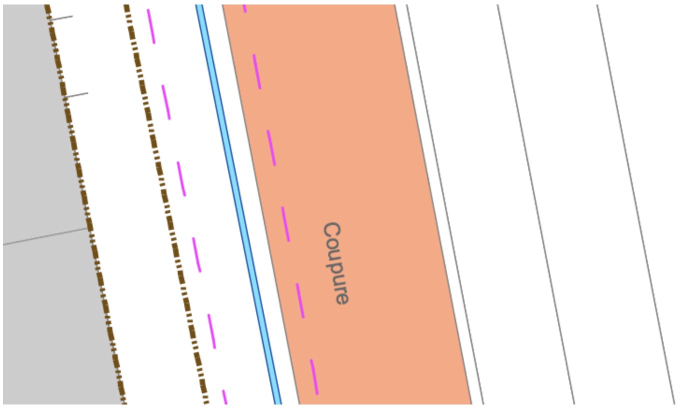


Figure 5.10: Average Section Coupure Links [51]

Practically, all available tools will be used on the Coupure Links and conclusions will be derived. Furthermore, the previous and current design will be compared and the consequences of the removal of the parking lane will be checked by the use of the CROW width tool. First, the acquired measurement data will be discussed.

5.2.1.1 Available data

Data was made available by Stad Gent in order to support and compare this theoretical analysis to reality. Several datasets have been made available of which the locations are visually represented on figure 5.11.

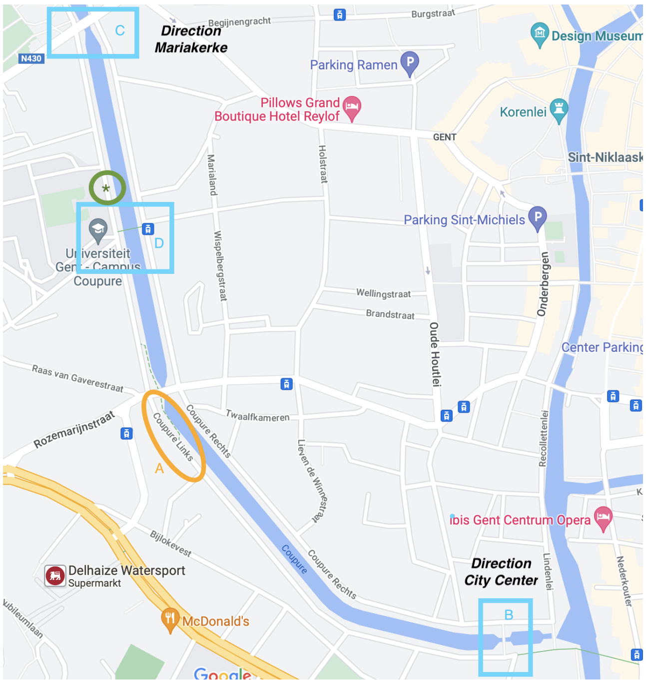


Figure 5.11: Plan View Coupure Links

As was mentioned, a counting device is installed on the Coupure Links, this is located near the green circled star on figure 5.11 and near the University Campus. Unfortunately, not all of this data is being transformed into datasets, due to which only the data that was collected until March of 2019 was accessible. Nevertheless, derivations could be made from the dataset and are summed below. Note that only the measurements up to the end of 2018 were taken into account as the three winter months of 2019 would not be a good representation for the average or peak values.

- The general increase in cycling is confirmed: from 2013 to the end of 2018, the yearly daily average of cyclists has increased by 28%.
- The morning rush hour is between 9:00 and 10:00. During this time frame the majority of people is travelling towards the city centre of Ghent.
- The evening rush hour is between 18:00 and 19:00. On this time of the day, the majority of people is travelling towards Mariakerke.
- In general, the morning rush hour is busier than the evening rush hour.
- The busiest rush hour that has been recorded is on 04/10/2016. Between 9:00 and 10:00, 1443 cyclists were recorded of which 1011 cycled in the direction of the city centre (70%).
- The highest amount of cyclists on one day was recorded on 17/10/2017 (a working day): 10 800 cyclists. 1153 during the morning rush hour and 1108 during the evening rush hour.

- Table 5.6 represents the average amount of cyclists during a day, the morning and evening rush hour during 2013-2018 and of 2018.

	2018	2013-2018
Total/day	7577	6967
Morning rush	804	690
Evening rush	758	653

Table 5.6: Average amount of cyclists - Coupure Links

- Table 5.7 represents the average shares of people travelling in the two directions during rush hour. This was calculated for both the year 2018 and the average of 2013 to 2018.

	2018	2013-2018
Towards Ghent in morning rush	68 %	70%
Towards Mariakerke in evening rush	66 %	66%

Table 5.7: Share of cyclists in the main direction - Coupure Links

The other measurement locations concern the separate counting of cars, cyclists and heavy vehicles. Three of them are located at intersections and are represented by the blue squares, labelled A, B and D. At all locations (except for A), measurements were performed from 7:00 to 18:00. For all cases, 7:30-8:30 and 16:30-17:30 were identified as morning and evening rush hour, respectively subscripts 1 and 2 are assigned to the corresponding values in what follows. For point D, a distinction was made between the measurements of vehicles towards the direction of Mariakerke and towards the centre of Ghent. This is because the intersection points towards two sides of the Coupure Links with different arrangements for car traffic. A corresponding subscriptm and G was assigned. Lastly, the orange oval, which is marked A, represents a measurement that was performed on the Roderoestraat, next to the Coupure Links, for this point, only the amount of cars and trucks are available on the Coupure.

Tables 5.8 and 5.9 represent the data that was generated and defines the moments of measurements for points A to D.

	C	B_1	B_2	A_1	A_2
Date	04/05/17	26/10/17	26/10/17	05/09/19	05/09/2019
Time	7:30-8:30	7:30-8:30	16:30-17:30	7:30-8:30	16:30-17:30
Cars	20	6	23	3	46
Cyclists	944	335	469	/	/
Trucks	1	0	1	/	/

Table 5.8: Available measurements Coupure Links (1)

	D_{1M}	D_{1G}	D_{2M}	D_{2G}
Date	17/10/17	17/10/17	17/10/17	17/10/17
Time	7:30-8:30	7:30-8:30	16:30-17:30	16:30-17:30
Cars	16	42	33	72
Cyclists	100	24	76	34
Trucks	2	2	2	1

Table 5.9: Available measurements Coupure Links (2)

Attention should be payed as these measurements are only snapshots of the real situation. Nevertheless, the results show comparable numbers regarding the truck intensity which is very low. Also the car intensity in all cases is lower than 50 cars/hour. Furthermore, the cycling intensity near point C corresponds in order of magnitude to the observations that have been made based on the datasets of the bicycle counting device that is installed near the university campus.

In order to perform the sensitivity analyses with the CROW width-tool, the share of duocyclists, mopeds and wide bicycles is necessary. As these values have not been measured over time, it is not possible to perform the analyses with representative data. Nevertheless, a sample was taken by performing measurements independently. This was done during a week day (not in a holiday). The corresponding results are shown in table 5.10.

Because the measurements were performed for half an hour, they are scaled times two in order to represent an hourly intensity. Furthermore they are scaled towards the rush hour time of the data from tables 5.8 and 5.9. Note that the rush hour of the counting device was not used because there is no reference with respect to the amount of cars and trucks in this way. It is clear that a lot of assumptions have been made. Therefore, these calculations are solely to be used to verify the capacity defined by the tool and to enhance the conclusions that will be drawn with a real life sample.

Total amount of vehicles Working day Time frame	443 17:00-17:30
Share of wide bicycles	4%
Share of mopeds	2.5%
Share of fatbikes	0.1%
Amount of cars	6 → 12/h
Amount of heavy load vehicles	1 → 2/h
Total amount of vehicles **Rush hour working day** Time frame	886 16:30-17:30

Table 5.10: Results sample measurement - Coupure Links

Nevertheless, the extrapolated hourly intensity of 886 from 16:30-17:30 coincides with the expectations. When comparing it to the available datasets until 2018 and then taking into account the continuous trend of growth, one can conclude that this is a realistic value. Furthermore, the weather was exceptionally nice on the day of the sample generation, which most likely had a positive effect on the amount of cyclists.

5.2.1.2 Application of CROW width-label Tool on Coupure Links

In the following sections, the CROW width-tool will will be applied on the Coupure Links. The current design; the bicycle street, will be compared to the previous one; the separate one-way bicycle path. Furthermore, the influence of the removal of the parking lane will be checked.

For all situations, the capacity will be determined based on the average assumptions.

Finally, the independently taken sample will be used to generate a simulation.

All of this has been performed according to the general approach, considerations and assumptions for the CROW-width tool, which have already been explained.

5.2.1.2.1 Current Design - Bicycle Street

The first part of the analysis consists of determining the effective width, B_{eff}, of the bicycle street. This depends on the obstacles on both sides. On the left side (parking side) 0cm of free space is assumed because there are almost permanently parked cars. Note there are no cars visible on figure 5.9 as this picture was taken just after the construction. On the right side, enough free space is assumed because of the green zone, but on this side, the kerb is higher than 5cm. As a result, also on this side a deduction of the available width is necessary. The corrections for the kerb on the right and the lack of free space on the left side are equal to respectively 25cm and 50cm (equation 5.1).

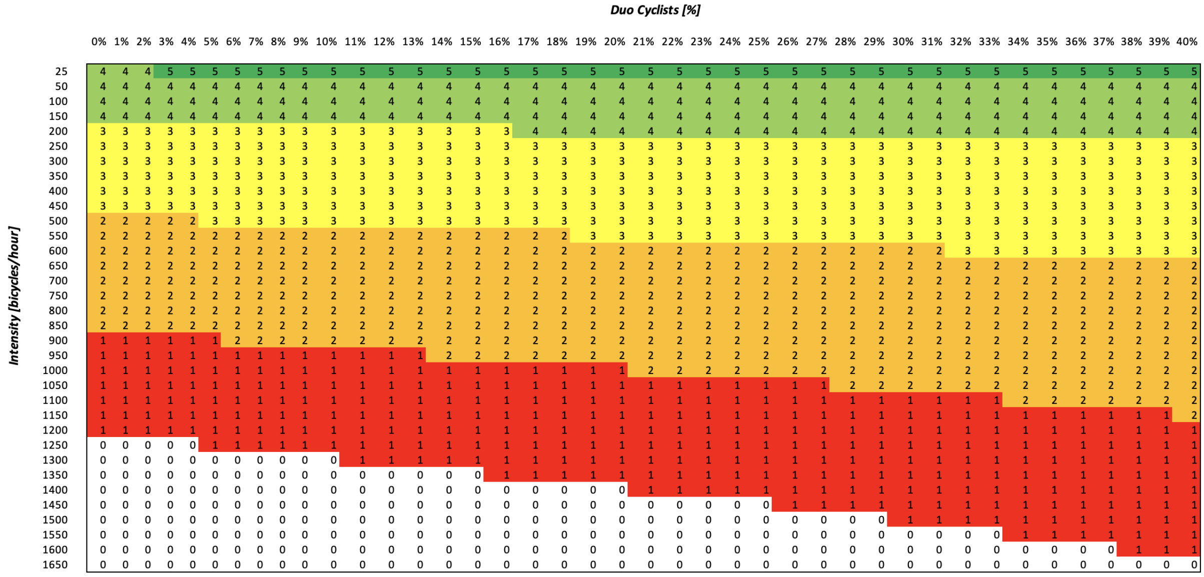
$$B_{eff} = 430 - 25 - 50 = 355cm \tag{5.1}$$

Based on this effective width of 355cm, the static width label is equal to B according to table 5.1. This corresponds to the recommended width provided in the CROW guidelines for general situations.

Concerning the share of mopeds, duocyclists and wide bicycles, the general assumptions are used (4%, 1% and 14%). For the share of bicycles in the main direction, the value of 66% is assumed, as it concerns a two-way cycleway. Taking into account these inputs, the sensitivity analyses can be performed with respect to the expected hindrances and dangerous encounters.

The matrices with the resulting hindrances width labels are provided below. The latter in terms of the hourly intensity depending on the investigated parameter; the share of duocyclists, wide cyclists, mopeds and the share of cyclists in the main direction, respectively in figures 5.12, 5.13, 5.14 and 5.15. Note that the figures are available in a bigger size in the appendices. Furthermore, they will only be presented in the text itself for this case in order to explain the principle. The other results will be solely provided in the appendices.

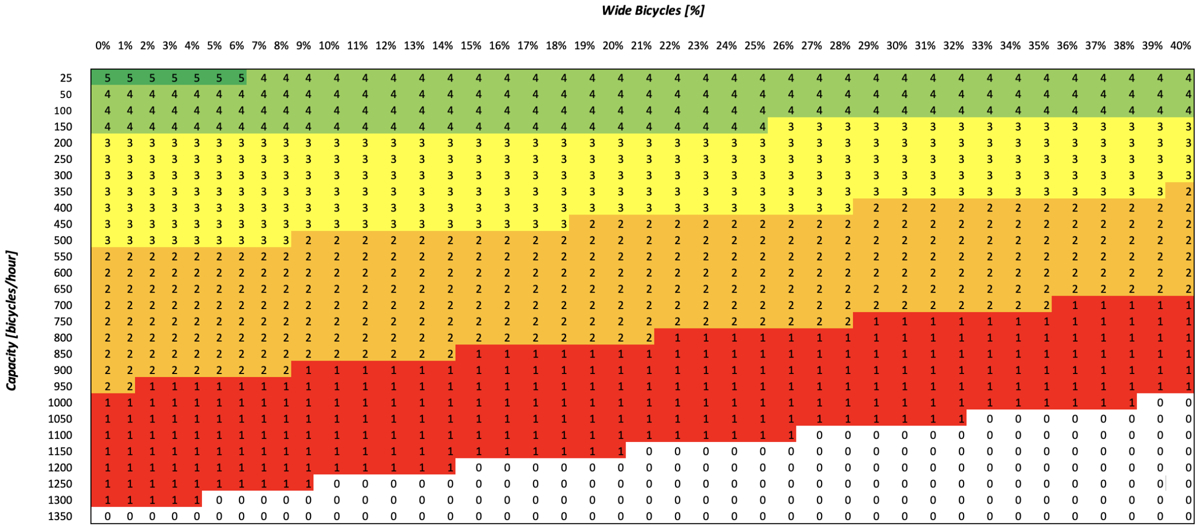
When interpreting the matrices, note that the resulting width label cannot be higher than B (or 4) as the final label is defined as the minimum of the static width and the hindrances label. As a result, the label 5 in the matrices solely corresponds to the hindrances level and not to the cycleway itself.



Duo Cyclists [%]

Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
50	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
100	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
150	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
200	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
250	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
300	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
350	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
400	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
450	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
500	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
550	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
600	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3
650	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
700	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
750	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
800	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
850	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
900	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
950	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1050	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2
1100	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
1150	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
1200	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1250	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1300	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
1550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
1600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
1650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

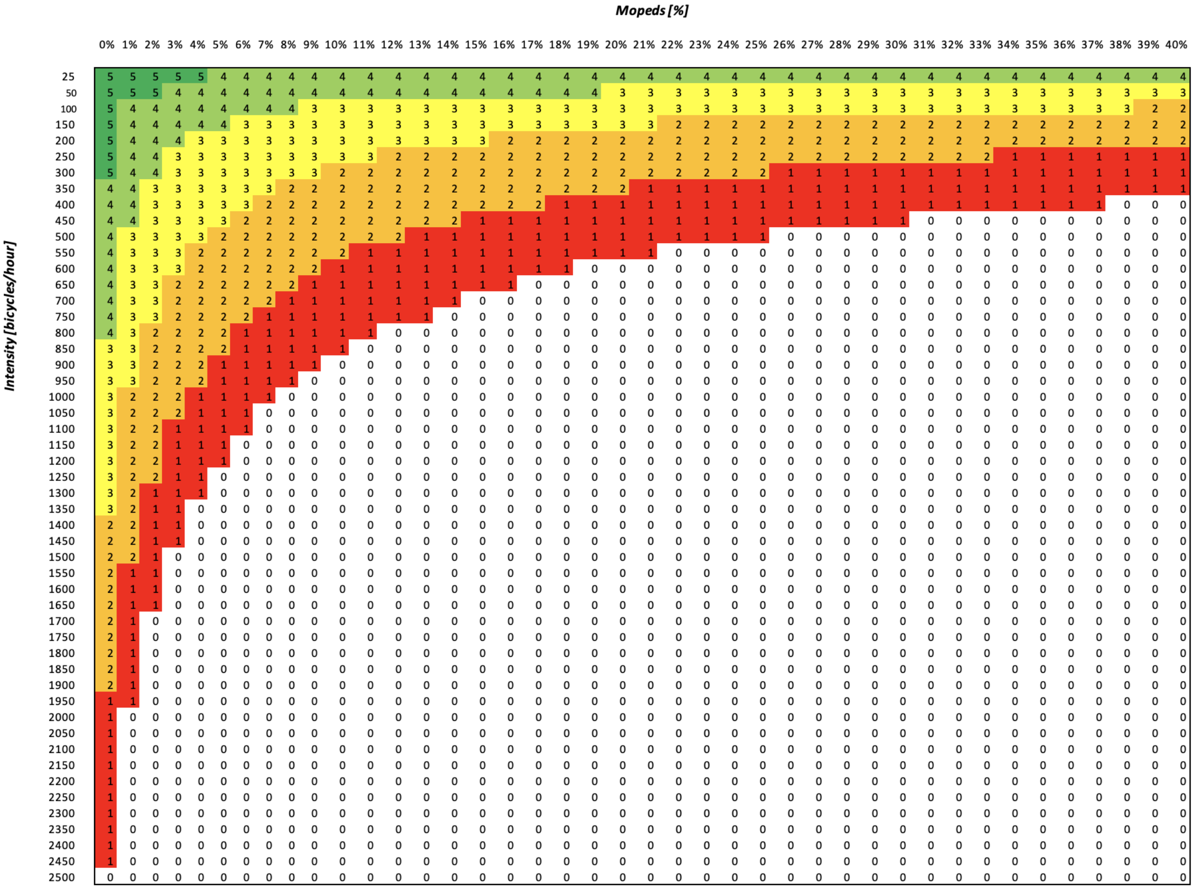
Figure 5.12: Matrix intensity vs share of duocyclists - Current design Coupure Links



Wide Bicycles [%]

Capacity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
50	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
100	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
150	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
200	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
250	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
300	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
350	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
400	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2
450	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
500	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
550	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
600	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
650	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
700	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1
750	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
800	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
850	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
900	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
950	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
1050	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
1100	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1150	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1200	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1250	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1300	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

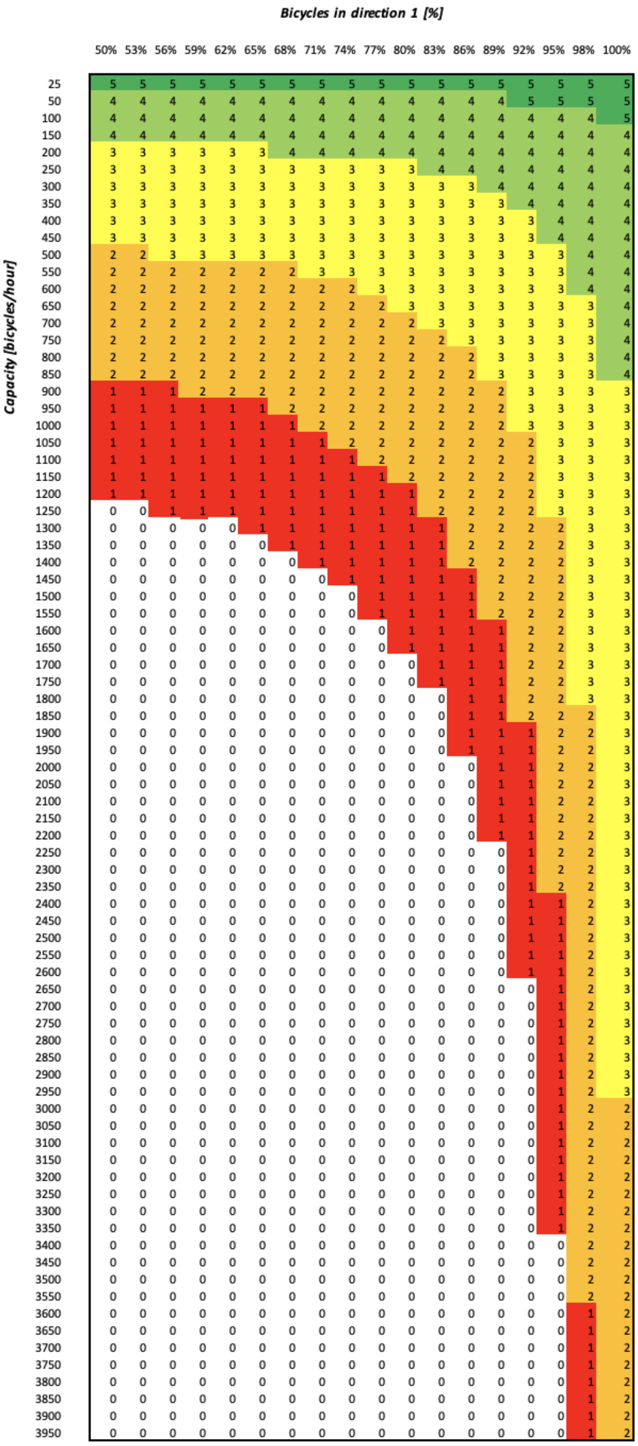
Figure 5.13: Matrix intensity vs share of wide cyclists - Current design Coupure Links



Mopeds [%]

Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
50	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
100	5	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2
150	5	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
200	5	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
250	5	4	4	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
300	5	4	4	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
350	4	4	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
400	4	4	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
450	4	4	3	3	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
500	4	3	3	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
550	4	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
600	4	3	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
650	4	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
700	4	3	3	2	2	2	2	2	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
750	4	3	3	2	2	2	2	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
800	4	3	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
850	3	3	2	2	2	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
900	3	3	2	2	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
950	3	3	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1000	3	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1050	3	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1100	3	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1150	3	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1200	3	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1250	3	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1300	3	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1350	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1400	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1450	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1500	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1550	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1600	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1650	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1700	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1750	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1800	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1850	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1900	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1950	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2050	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2100	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2150	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2200	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2250	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2300	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2350	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2400	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2450	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 5.14: Matrix intensity vs share of mopeds - Current design Coupure Links



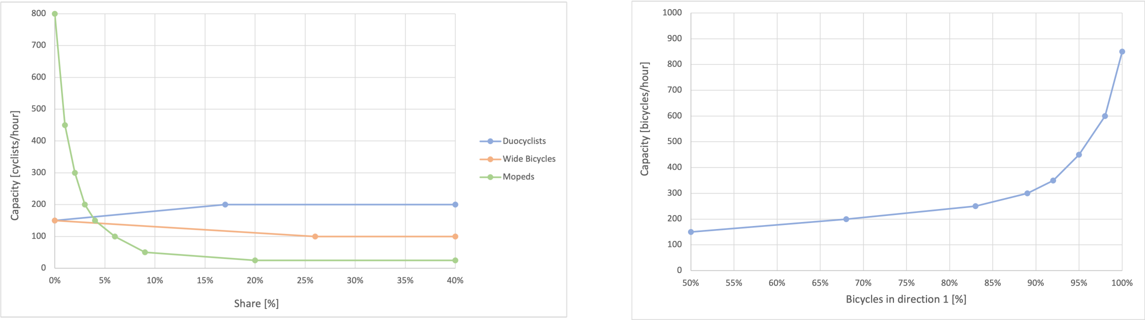
Bicycles in direction 1 [%]

Capacity [bicycles/hour]	50%	53%	56%	59%	62%	65%	68%	71%	74%	77%	80%	83%	86%	89%	92%	95%	98%	100%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
50	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5
100	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5
150	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
200	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4
250	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4
300	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4
350	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4
400	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4
450	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4
500	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4
550	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4
600	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4
650	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4
700	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4
750	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4
800	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4
850	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4
900	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
950	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3
1000	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3
1050	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3
1100	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3
1150	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3
1200	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3
1250	0	0	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3
1300	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	3	3
1350	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	3	3
1400	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2	2	3	3
1450	0	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3	3
1500	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
1550	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
1600	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	3
1650	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	3
1700	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3
1750	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3
1800	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3
1850	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	2	3
1900	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3
1950	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
2050	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
2100	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
2150	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
2200	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
2250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3
2350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3
2400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
2450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
2500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
2550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
2600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
2650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
2700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
2750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
2800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
2850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
2900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
2950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
3450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
3500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
3550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
3600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2

Figure 5.15: Matrix intensity vs share of cyclists in the main direction - Current design Coupure Links

According to the explanation in the section 'Considerations in applying the CROW width-label tool', the capacity of a cycleway is defined by label B (4). Looking at the matrices, this corresponds to the transition between the light green and the yellow zones. In what follows, the corresponding lines at the transition zone will be referred to as the 'capacity lines'. These lines are represented in figure 5.16 and 5.17 for the current bicycle street design of the Coupure Links.

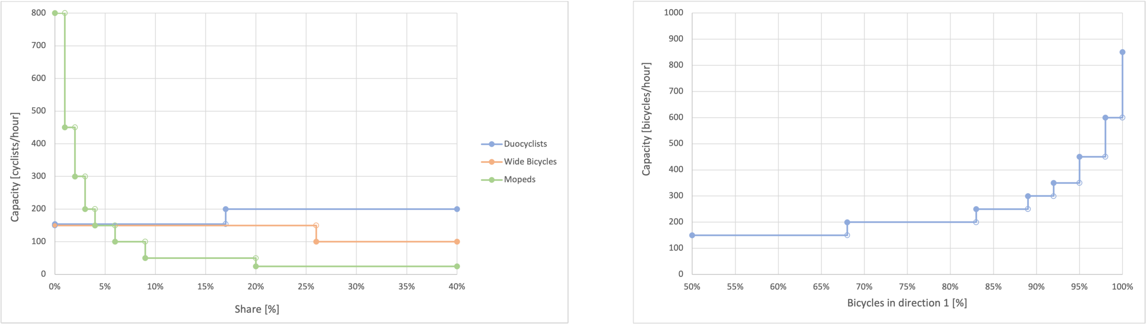
Two representations were adopted for the visualisation of the capacity lines, this is because of mathematical considerations. More specifically, the lines were constructed by pointing out the 'shifting points' in the matrices. In between the points, the same value of intensity was generated in the matrix. Nevertheless, as this is a discrete approach, an intensity of 150 cyclists/hour actually corresponds to an intensity in the interval of $[150, 200[$ cyclists/hour. As a result of this approach, mathematically speaking, the discrete step representation of figure 5.17 is the most correct. Nevertheless, due to the linear interconnection of the shifting points in 5.16, the relationships between the parameters are visually more clear. As a consequence, in the following part of this master's thesis, the choice was made to apply this visualisation technique. Furthermore, values in between the shifting points will not be quantified.



(a) Shares of duocyclists, wide bicycles, mopeds

(b) Share in the main direction

Figure 5.16: Capacity lines: linear interconnection - Current design Coupure Links



(a) Shares of duocyclists, wide bicycles, mopeds

(b) Share in the main direction

Figure 5.17: Capacity lines: discrete steps - Current design Coupure Links

Taking into account the assumed shares for the analysis -14 % duocyclists, 4% mopeds, 1% wide bicycles and 66% of cyclists in the main direction, a capacity of 150 cyclists/hour can be found-both from the matrices and the capacity lines.

Some further observations are made based on the graphs and matrices:

- It is clear that the value of the hindrances width-label greatly depends on the share of mopeds. The capacity increases exponentially with decreasing moped share. As an indication, the capacity equals:
  - 800 cyclists/hour for 0% mopeds
  - 450 cyclists/hour for 1% mopeds
  - 300 cyclists/hour for 2% mopeds
  - 200 cyclists/hour for 3% mopeds
  - 150 cyclists/hour for 4% mopeds (current assumption)
  - 25 cyclists/hour for 40% mopeds

  If mopeds would be banned for the Coupure Links -under the assumed shares- the capacity would increase by 533%.
- The higher the intensity, the higher the negative impact of the share of wide bicycles, especially when overtopping the capacity.
- The higher the intensity, the higher the positive impact of duocyclists. A share of 17% duocyclists increases the capacity up to 200 cyclists/hour. Once again, this effect is more outspoken once the capacity is overreached.
- The overall influence of the share of wide bicycles and duocyclists is small compared to the influence of the share of mopeds.
- If the bicycle street would become a one-way street, under the current 'user composition' assumption, the capacity increases up to 950 cyclists/hour.

An summary of the current design option, the bicycle street of the Coupure Links and its capacity is given in table 5.13.

Design	**Current - bicycle street**
Directions	two-way
B	430cm
B_{eff}	355cm
Static width label	B (4)
Capacity	150 bicycles/hour

Table 5.11: Summary - Current design Coupure Links

5.2.1.2.2 Previous Design - One-way Cycle Path

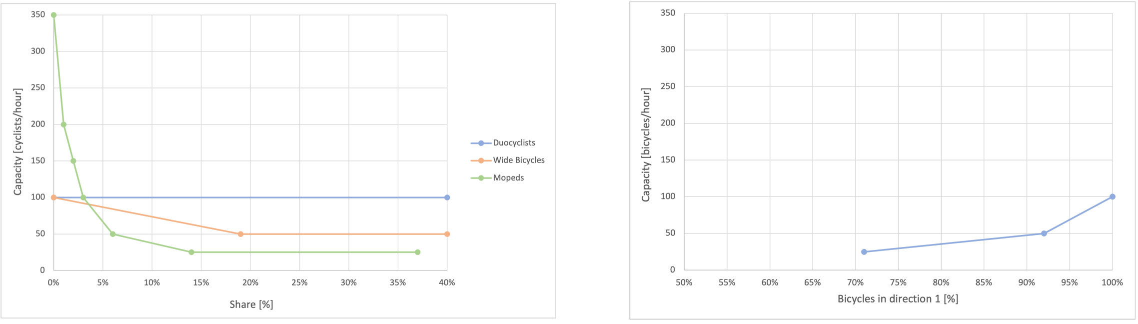
Analogue to the previous section, the effective width is determined for the previous design of the Coupure Links, the separated one-way cycle path. In this case, no kerbs are present and only the right side of the cycle path holds restricted zones formed by the bushes. It is assumed that the grass strip before the bushes is approximately 20cm wide. The latter width is deducted from the 50cm that should be deducted as a correction for free space.

$$B_{eff} = 250 - (50 - 20) = 220cm \tag{5.2}$$

Based on this effective width of 220cm generated by formula 5.2, the width label is equal to B. This corresponds to the recommended static width provided in the CROW guidelines (table 5.1).

Secondly, the shares concerning the user composition on the cycleway are defined. As it concerns a one-way cycle path, the share related to the main direction is set equal to 100%. Furthermore, the general assumptions concerning mopeds, duocyclists and wide bicycles are used.

Again, the sensitivity analysis on the hindrances and dangerous encounters is performed. The resulting matrices are provided in the appendices. Figure 5.18 represents the corresponding capacity lines.



(a) Shares of duocyclists, wide bicycles, mopeds

(b) Share in the main direction

Figure 5.18: Capacity lines - Previous design Coupure Links

The capacity can be read from both the matrices and the capacity lines by checking the assumed shares, it is equal to 100 cyclists/hour.

The following observations have been made:

- The moped share has once again a big influence, if their share would be equal to zero, the capacity increases until 350 from 100 bicycles/hour. This is more than triple. Furthermore, an increase of up to 38% of mopeds results in a capacity which is lower than the threshold of 25 cyclists/hour.
- The share of duocyclists does not influence the capacity for this one-way cycle path and its assumed user composition. But, once the capacity is exceeded, the higher the intensity, the higher the positive effect of an increasing share of duocyclists.
- The negative effect of wide cyclists decreases under increasing share. The capacity is halved in the case of 19% wide bicycles. When the intensity overtops the capacity, the negative influence is enlarged.
- If 7% of the users of the bicycle path are ghost drivers, the capacity halves to 50 bicycles/hour. Furthermore, starting from 29% of ghost drivers, the capacity becomes smaller than the threshold of 25 cyclists/hour.

Table 5.12 summarizes the findings of the analysis on the previous one-way cycle path at Coupure Links.

Design	**Previous - separate cycle lane**
Directions	one-way
B	250cm
B_{eff}	220cm
Static width label	B (4)
Capacity 4% Mopeds Capacity 0% Mopeds	100 bicycles/hour 350 bicycles/hour

Table 5.12: Summary - Previous design Coupure Links

5.2.1.2.3 Consequences of the removal of the parking lane

Lastly, the effect of the removal of the parking lane is checked. Note that is not a planned intervention, it only concerns a conceptual check.

The street now holds a width of 650cm (430cm original street + 2m parking lane + 20cm gutter). By taking into account a reduction due to the kerbs on both sides, which are higher than 5cm, an effective width B_{eff} of 580cm is found (formula 5.3).

$$B_{eff} = 650 - 25 - 25 = 600cm \tag{5.3}$$

This value of effective width corresponds to the highest width label A (5).

Taking into account the average shares for duocyclists (14%), wide bicycles (1%), mopeds (4%) and cyclists in the main direction of a two way cycleway (66%), the sensitivity analyses with respect to the hourly intensity and hindrances were once again performed on the four influencing parameters.

Similarly to the previous designs, the hourly intensity was varied until 4000 cyclists per hour. The findings regarding the hindrance label were positive: label A was dedicated to the bicycle street for every possible combination. Note that the resulting matrices are not included in the appendices due to their monotonous character. The analyses were stopped at 4000

It can be concluded that removing the parking lane on the Coupure Links results in a big increase of capacity and comfort towards hindrances and dangerous encounters. Furthermore, it can form a viable solution to the increasing number and diversity of cyclists in the future (e.g. cargobikes. Even an increase to 40% share of mopeds, which in the other designs is the most influential, is resisted.

Design	**Bicycle street without parking lane**
Directions	two-way
B	650cm
B_{eff}	600cm
Static width label	A (5)
Capacity	> 4000 bicycles/hour

Table 5.13: Summary - Design without parking lane Coupure Links

5.2.1.2.4 Comparison of the design options and suggestions

After the theoretical analyses of different design options, a comparison is made in this paragraph. Furthermore, suggestions on decision making are given. (Note that a practical application of the gathered data into the tool will be provided in the following section.)

When comparing the previous separate cycle path to the current bicycle street that is established at Coupure Links in terms of capacity, both designs are similar. The bicycle street has a capacity of 150 bicycles/hour in two directions, while the separate cycling lane had a capacity of 100 cyclists/hour. Nevertheless, one could be in favour of the current bicycle street because of its higher total capacity and by taking into account the dual character of the Coupure Links - the destination of the university Campus and a corridor towards the centre.

First of all, it is noted that both capacities are rather low compared to the data that was acquired. Despite this, there is a clear difference in the capacity that can be reached depending on the shares of the 'bicycle type composition' and share in the main direction. As was noted before, the moped share is the most important parameter. If one were to assume that in the case of the one-way cycle path, all mopeds were to drive on the street, the capacity this design increases up to 350 bicycles/hour. This is an assumption that might be close to reality as it was previously more convenient for them to drive on the street and share space with the cars than to ride on the separate bicycle path.

Similarly, if mopeds were to be banned from the bicycle street, a capacity of 800 bicycles/hour is to be expected for the current design. Under the current assumption of 66% of cyclists in the main direction, this implies 533 cyclists/hour in the main direction and 267 in the other. Nevertheless, the latter restriction is not convenient to be made in Belgium (nor Ghent in specific) due to which this might not be a realistic suggestion. Furthermore, in practice, cars can also pass the street, so solely banning mopeds is not a practical suggestion or solution. Nevertheless, an important remark holds the fact that until now a 4% share was considered for mopeds and as was mentioned, a decrease by 1% or 2% already increases the capacity up to respectively 200 and 300 bicycles per hour. The latter is already double of the original value of 150 cyclists/hour.

Another significant difference is noted in terms of the share of bicycles in the main direction. In the case of the previous one-way design, the capacity is not able to reach the minimum value of 25 cyclists/hour (which was defined as practically applicable) for any share lower than 71% in the main direction. This means that the previous design was certainly not resistant towards ghost drivers. But in the mean time, it is plausible to accept that there were at least several, due to the important destinations that are on the Coupure Links, e.g. the University Campus. Already 7% of ghost drivers cause the capacity to halve. Concerning the bicycle street, the available data confirmed the assumption of 66%, so no further considerations are made.

Finally, taking into account the observations, it is clear that the previous bicycle path did not succeed to satisfy the cyclists on the Coupure Links and that an intervention was needed. On the one hand, due to the important destinations on the street that imply cyclists in two directions. On the other hand, due to the design's incapacity to process an increase in moped share or wide bicycle share.
Nevertheless, under the assumptions of CROW (being 14% duocyclists, 4% mopeds and 1% of wide bicycles) the current bicycle street is (also) not at all able to withstand to the measured intensities from table 5.6, according to the analysis. When the average morning rush hour of 2018 is considered (804 cyclists/hour), a gap of roughly 650 cyclists/hour with respect to the capacity needs to be overcome. Taking a look to the matrices that have been designed (figures 5.12 5.13, 5.14 and 5.15), this capacity corresponds to the orange zone of label D(2). According to table 5.4, that has been defined by the research of CROW and DTV, there is a big chance of

hindrances and dangerous encounters and thus the capacity is severely overreached.

Subsequently, next to the suggestion concerning the ban of mopeds that has already been discussed, two other *theoretical* solutions are proposed to overcome the issue of capacity versus intensity.

1. Ban mopeds from the bicycle street.
   Capacity of **800 cyclists/hour**
2. Remove the parking lane.
   Capacity of >**4000 cyclists/hour**
3. Increase the effective width to $B_{eff} = 380$cm: remove or lower the kerb on the right side in order to increase the effective width with 25cm
   Capacity of **450 cyclists/hour**

The second intervention would cause a huge increase in capacity and a big reduction in the amount of hindrances and dangerous encounters as was established during the previous analysis. Furthermore, it ensures a resilience towards the further increase of cycling in general, the rise of cargobikes and the rise of type 1 and especially type 2 e-bikes. On top of this, mopeds could keep on using the street without limiting the capacity. When choosing this option, it could be useful to consider the design recitals that were shown by the example of Singapore in figure 5.3(b). In this case, the big street could be divided in zones according to speed. For example, a bicycle street with the current effective width of 355cm could remain in the centre and the remaining zones could be arranged for slower traffic. Like this, mopeds, e-bikes of type 2 or wide bicycles could use this centre lane, while slower or more vulnerable cyclists could use the side lanes.

The last option concerns the removal of the kerb on the right side. It is a relatively small intervention that would result in an increase of the effective width of 25cm and thus yield a total width of 380cm. Subsequently, one could aim to reach static width label A(5), a width of 400cm is required and thus 20cm more space would be needed. Practically, this could be realised by re-designating this width from the adjacent green zone. The effect on the hindrances label of these proposed interventions has not been researched in detail, only the capacities have been determined: respectively 450 and 500 bicycles/hour. There is a clear increase in capacity but, as was expected not until the measured intensities. An overview of the corresponding capacities with respect to the effective widths is given in table 5.14. It strikes that the transition from an effective width of 355cm to 380cm results in an increase from 150 to 450 cyclists/hour, while the further increase up to 400cm only leads to a capacity of 500 cyclists/hour based the CROW width tool. It can be noted that this small intervention of removing the kerbside on the right side would yield the best return on investment when choosing between the different options in order to distress the bicycle system on the Coupure Links.

B_{eff} [cm]	Capacity [cyclists/hour]
355	150
380	450
400	500

Table 5.14: Effect of B_{eff} on Capacity of current design - Coupure Links

Finally, two notes are made. An important remark holds the fact that this analysis was performed by neglecting the influence of the cars on the cyclists in the current design or the bicycle street. This choice was made based on several considerations, the first one holds the very low car intensity. The second one holds the secondary effect of cars in a bicycle street: as a car cannot overtake cyclists and a lot of cyclists stay behind it, less encounters will happen and thus less dangerous encounters and hindrances will be experienced. Inherently, it is thus assumed that motorists know and follow the rules. Nevertheless, in practice the presence of cars will undeniably have consequences on the behaviour of cyclists, their experience of hindrance and as a result the definition of capacity. Unfortunately, more research is needed to quantify this influence and to be able to implement it in the tool.

The second remark holds the fact that the CROW tool assumes cyclists to use the space effectively, hold the minimum distance etc. In practice it was noted that this is not always the case, for example a certain share of cyclists still uses the old bicycle path near the water front.

5.2.1.2.5 Practical application of the sample and interpretation of the results

From the previous paragraphs, it is clear that the assumptions on 'cycling composition' have an important influence on the outcomes of the studies. As a result, based on the gathered data, a final analysis has been performed by using the CROW width-tool on the current design of the Coupure Links. This time, the assumptions in table 5.15 were used as inputs to the model. Note that the share of duo cyclists has not been quantified by measurements and was thus kept equal to original 14%.

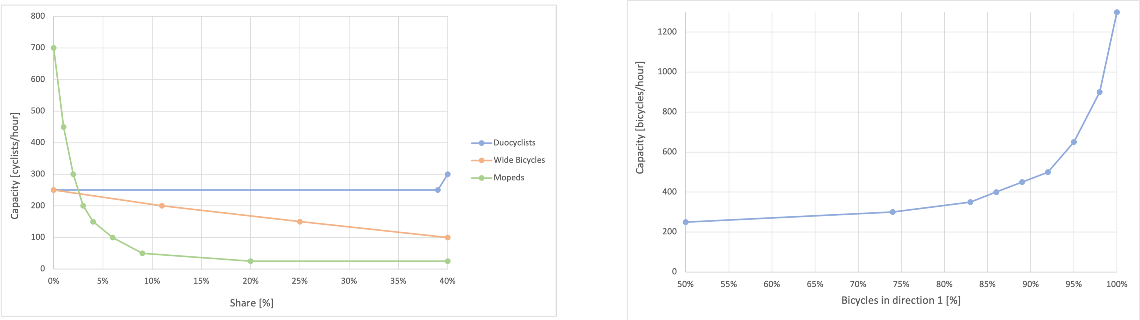
Cyclists in the main direction	66%
Mopeds	2.5%
Duocyclists	14%
Wide bicycles	4%

Table 5.15: Assumed shares

The resulting matrices of the analysis are presented in the appendices and the capacity lines are given below in figure 5.19. Taking into account the current design of the Coupure Links and the user composition during the collection of the sample, a capacity of 250 bicycles/hour was found by the analysis. This holds an increase of 66% compared to the theoretical value that was generated based on the general assumptions.

Again, some considerations can be made:

- The influence of the user composition on the capacity and on the chance of hindrances and dangerous encounters, is similar to the theoretical analysis that has been performed on the current design of the Coupure Links under the general DTV and CROW assumptions.
- The absolute values of intensities that can be handled under a specific share of duocyclists and wide bicycles are higher. This was to be expected due to the lower share of mopeds, which was shown to have the biggest influence.
- The same observations hold for the share of cyclists in the main direction.
- On the contrary, the moped share reaches lower intensities under a specific share. This is due to the increase of wide bicycles compared to the original CROW and DTV assumptions.



(a) Shares of duocyclists, wide bicycles, mopeds

(b) Share in the main direction

Figure 5.19: Capacity lines - Sample application - Coupure Links

When comparing this calculated capacity of 250 cyclists/hour to the independently taken sample which coincided with an intensity of 886 cyclists/hour, a big difference is observed. Nevertheless, during the observation of the taking of the sample, no excess hindrances or dangerous encounters were observed. Looking in the matrices, the capacity of 886 cyclists is situated in the orange zone which corresponds to label D(2) and to a big chance of dangerous encounters - under the assumed user composition (this is similar to the theoretical analysis). As an indication, table 5.16 shows the corresponding capacity of this specific case, if it were to be defined by a different label.

Label as definition	Capacity [cyclists/hour]
A(5)	25
B(4)	250
C(3)	600
D(2)	1100
E(1)	1500

Table 5.16: Capacities depending on definitions - sample Coupure Links

Furthermore, one should once again take into account that the effect of cars in the bicycle street was neglected in all previous analyses where the CROW-width tool was used. On the one hand, it was explained why this is a justified assumption. On the other hand, if a correction were to be made for this aspect, an even more negative result would be found with respect to the available capacity. The same holds for the ineffective behaviour of cyclists
To conclude; this simulation based on a real life sample confirms the theoretical observations that have been made before.

1. According to the CROW width tool, the capacity of the Coupure Links under the current design is not sufficient with respect to the intensities and user composition that have been measured.

2. In reality, a negative correction to the obtained capacity of 250 cyclists/hour should be made in order to take into account the effect of cars in the bicycle street. The same holds for the behaviour of cyclists

3. Possible interventions that are able to increase the capacity are listed in the previous paragraph.

4. One might question the strict definition of capacity according to CROW as during the sample generation, no excess hindrances or dangerous encounters were observed and the

static width label is sufficient.

5.2.1.3 Tfl New Cycleway Quality Criteria Tool

Another practical application that has been performed, holds the Quality Criteria Tool from Transport for London. The tool was used on the Coupure Links in order to check if the street is suitable to apply space sharing. As the tool works with undisturbed links and inputs concerning measurements of car traffic, heavy loads traffic and bicycle traffic are needed, it was chosen to work with with the data that was obtained at the intersections C and D from figure 5.11. These points and corresponding links were chosen because they show respectively the highest amount of cyclists and cars (for D_{2G} in specific). Furthermore, C lies at an important junction near Nieuwewandeling. The latter will be relevant in the application of the tool.

The first part of the tool answers the question 'Are existing conditions expected to be suitable for people cycling to be mixed with motor traffic?'. The inputs that are required are the fact that it concerns a one-way street, the peak motor flows (respectively 20 and 72 for C and D), the 85 percentile speed (this was assumed to be equal to 25 km/h), the peak HGV flow (both equal to 1) and the ratio with respect to the amount of cars during that hour. In this case, only data from one hour is available so respectively 5% and 1.4% are found. Furthermore, the width of the general traffic is asked as well as the inclusion of kerbside parking/loading area: a total of 6.6m of which 2.2m corresponds to parking and loading zone. Finally an input is asked concerning the turning risk at a major junction. As point D does not have one, not applicable is indicated. As for point C, it can be concluded that the existing arrangements fulfil the safety criteria by taking into account the cycleway -that has been opened on May 16th 2022 [52]- going underneath the bridge at the junction. Taking into account these inputs, for both cases, the answer to the question yields 'Yes' and thus it can be concluded that both links of the Coupure Links are suitable space sharing.

Secondly, the tool checks if there is a light segregated cycle lane or if a full separation is currently provided on the street. For both cases, the answer to this question is no, due to which a recommended action is generated: 'Expected to be suitable for cyclists to be mixed with general traffic'.

The third and last part of the tool consists of potentially suggesting additional design considerations. These questions are related to cycling facilities. First, it is indicated that the cycleway is arranged as a two-way cycle street. Next, the width of the shared facility is provided (4.3m for both links), it is indicated that there is no buffer zone adjacent to kerbside activity where a cycle lane is provided. Furthermore, it is asked if there is an arrangement with respect to early cycle release at junctions and if conflicting movements between cycle traffic and motor traffic are separated with dedicated signals. Both questions are answered with 'no' for both cases after which the tool generates 'Address signal design issues'.

As a general conclusion, it can be noted that the tool is definitely useful and that the theoretical considerations behind it -which have been discussed before- are well thought out. All questions that have to be completed are provided with extra information in order to ensure a correct understanding. Nevertheless, the questions are still very subjective. An example is the question concerning 'conflicting moments' between cyclists an motor traffic. On top of this, the tool does not take into account a lot of parameters concerning the bicycle system itself. For example, the cycling intensity was not needed in order to complete the analysis, while this should be a crucial factor in defining whether or not to opt for space sharing. Next, the applicability outside of the United Kingdom might be limited as the third part with respect to signalisation is very specific according to their rules and regulations. Furthermore, when the suggestion is given address signal design issues', this remains very vague and open for interpretation.

5.2.1.4 MORE Option Generation Tools

In order to be able to apply both of the MORE-tools, a total width of 15m needs to be considered. Nevertheless, in the current design, only 13.6m is available. As a result, it is assumed that the bushes on the right side of the cycle path are removed and an extra 1.4m was made available. Alternatively, this increased cross section could be obtained by narrowing the green zone around the trees.

Streetspace Design Tool
As an input for the tool -and as a consequence of the assumption of increased width that has been mentioned above- the following division of the street was entered into the tool (table 5.17). An important remark holds the fact that there is no option available to indicate a bicycle street. The most convenient options for this case are 'general traffic', 'cycle lane or cycle track' and 'mixed bus and cycle lane'. As the bicycle street in the current design is not a separated cycleway, is not dedicated to busses, but used by different types of motorised traffic and cyclists, the option of general traffic was chosen.

Walking	4.5m
Green area	4m
General traffic	4.3m
Parking	2.2m

Table 5.17: Input about current situation

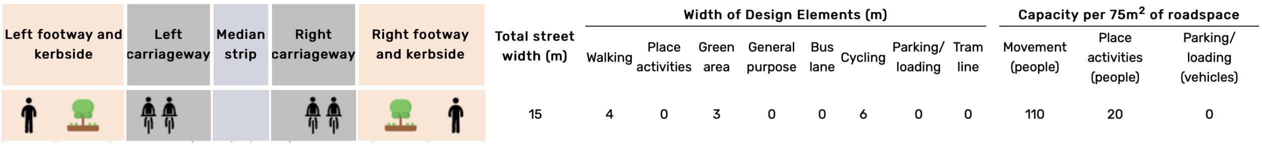
Secondly, priorities (between 0 and 2) have to be assigned to different street uses. In practice, different trials have been attempted, as well as an assessment with the current configuration. The corresponding inputs are given in table 5.18. Note that when this current situation was assessed, no available street designs were found.

Concerning the other trials, of course, in line with the general topic of this master's dissertation, cycling was made a priority and received a number 2 in all cases. Both, with the aim of creating a more liveable street' and by taking into account that the removal of the trees is not an option: green area received a 1. Subsequently, also walking was considered important and received a one in both cases. In case of parking and loading area, for the two trials, this was removed as a consequence of the findings in the CROW width label analysis. Tram lines, bus lanes and place activities are chosen not to be included due to a lack of space. Lastly, the influence of general traffic on the proposed designs was checked. The tool was run for a priority level of 0 (trial 1), 1 (trial 2), 2 (trial 3). Also the second trial did not result in any proposed designs.

Design element	*Current Design*	*Trial 1*	*Trial 2*	*Trial 3*
Walking	1	1	1	1
Place activities	0	0	0	0
Green area	1	1	1	1
General traffic	1	0	1	2
Bus lane	0	0	0	0
Cycling	2	2	2	2
Parking	1	0	0	0
Parking and loading	1	0	0	0
Tram lines	0	0	0	0

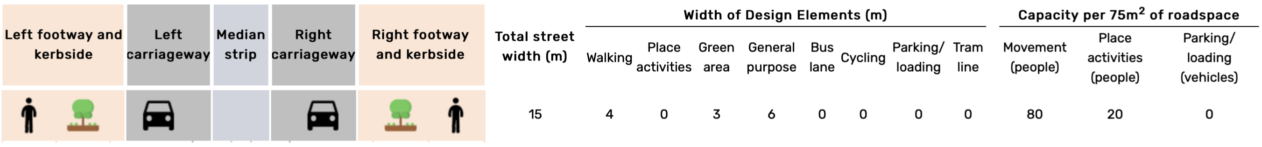
Table 5.18: Priority list

Figures 5.20 and 5.21, respectively represent the outcomes of the first and third trial.



						Width of Design Elements (m)								Capacity per 75m^2 of roadspace		
Left footway and kerbside	Left carriageway	Median strip	Right carriageway	Right footway and kerbside	Total street width (m)	Walking	Place activities	Green area	General purpose	Bus lane	Cycling	Parking/ loading	Tram line	Movement (people)	Place activities (people)	Parking/ loading (vehicles)
🚶 🌳	🚲 🚲		🚲 🚲	🌳 🚶	15	4	0	3	0	0	6	0	0	110	20	0

Figure 5.20: Result trial 1



						Width of Design Elements (m)								Capacity per 75m^2 of roadspace		
Left footway and kerbside	Left carriageway	Median strip	Right carriageway	Right footway and kerbside	Total street width (m)	Walking	Place activities	Green area	General purpose	Bus lane	Cycling	Parking/ loading	Tram line	Movement (people)	Place activities (people)	Parking/ loading (vehicles)
🚶 🌳	🚗		🚗	🌳 🚶	15	4	0	3	6	0	0	0	0	80	20	0

Figure 5.21: Result trial 3

The two designs which have been generated are both symmetrical designs without innovative concepts. Furthermore, the designs are exactly the same except for the exchange of cars and cyclists. In addition, the third trial does not provide space for cyclists, even though it was given priority. This might partly be due to the fact that the street section only holds the minimum required width and as a result, does not allow that many options. Nevertheless, more than one option would be welcome and feasible.

What provides great added value to the tool, is the fact that it generates the capacity for every design. When comparing the car alternative to the bicycle option, a difference of 30 people/hour is found in favour of the cycle lane option. This function might help policy makers to make a better decision and provide them with more insights.

It can be concluded that the tool might yield valuable suggestions in general street designs, especially when considering the mentioned capacity. Nevertheless, it might not generate the most innovative designs and it might be more appropriate to use on streets with larger sections. Furthermore, its application with the aim of creating a better cycling environment might not be ideal due to the limited amount of parameters that are taken into consideration. Lastly, as was mentioned during the introduction of the tool, the bicycle guidelines originate from NACTO. As can be concluded from appendix B, these are definitely not the most encompassing ones and will not yield the safest designs.

MORE Streetspace intervention tool
The second tool of MORE that will be applied is the streetspace intervention tool which is independent of the current design.

In this case, the first input concerns the priority list. Here, 0 stands for can be worse of then now, 1 means should not be worse of then now and 2 stands for should be better of than now. Only three items can be given priority 1 and 2. The respective items consists of a combination of street user and street use. Of course, it was decided to give cyclists priority 2 to move, a priority 2 was also adapted for cyclists parking due to the destination function of the university campus. Furthermore, pedestrians were given priority 2 to walk. The car drivers are given priority 1 to move, 0 to park. Finally also motorcyclists and emergency vehicles are assigned priority 1 to move.

Secondly, objectives need to be defined from six classes: movement, place, street operation, wider economic objectives, wider social objectives and wider environmental objectives. A maximum of 5 can be chosen. For the aim of this case study, the decision was based on the characteristics and the advantages of an established bicycle system that have been highlighted in the literary review. This was done in order to enhance the outcome of cycle friendly interventions.

A first trial was attempted based on the following objectives:

1. Improve trip quality (movement)
2. Achieve a more sustainable modal split (movement)
3. Improve traffic safety (social)
4. Improve air quality (environmental)
5. Improve access to local buildings (place)

No options were generated based on this selection. As a result, objective four and five were omitted. Now, two results are generated: 'Kiss and Ride' and 'Park and Ride'. What follows is a very detailed list of effects and examples.

A second trial:

1. Reduce congestion (movement)
2. Achieve a more sustainable modal split (movement)
3. Improve traffic safety (social)
4. Facilitate kerbside activities (place)

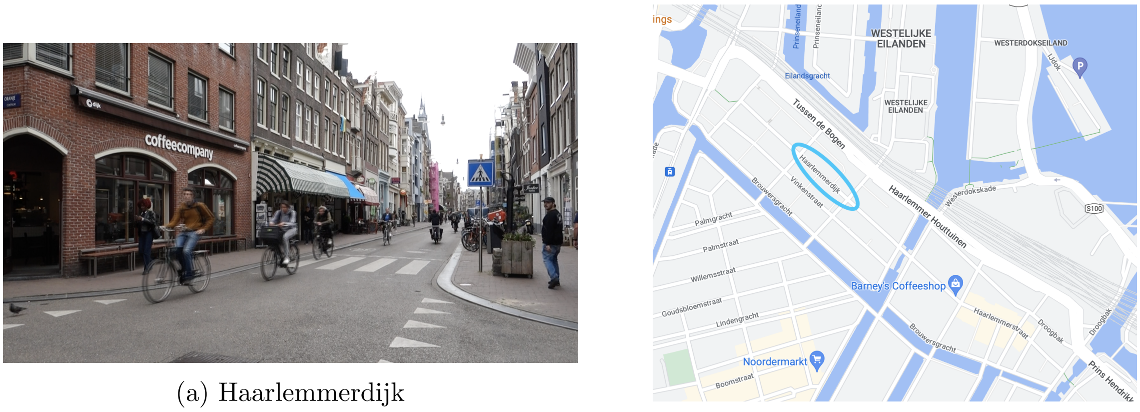
Now, the same two interventions are proposed. If the fourth objective is removed, two extra suggestions are made: 'Decrease number of parking spaces' and 'Parallel parking spaces'. Once again a detailed explanation is given for the different options. As an example, the outcomes the removal of parking spaces are provided in appendix F.

Once again, it can be concluded that the tool might provide useful insights in the general streetspace design, but that it does not spend a lot of attention to the bicycle system in specific. As a result, the application of the tool might not necessarily result in a better cycling environment. The same remarks are made with respect to the street width and use of the American NACTO guidelines.

5.2.2 Case study - Haarlemmerdijk, Amsterdam

Haarlemmerdijk is a shopping street in the city centre of Amsterdam. Furthermore, it forms an important connection and corridor from Haarlem towards the central station. This dual character already implies a first important observation. Haarlemmerdijk concerns a street accommodating two-way cycling with on the one side; a pedestrian zone and on the other side; a multi functional zone for bicycle parking/(un-)loading (depending on the longitudinal position) and another pedestrian zone. Mopeds are not allowed, neither are cars, only priority service vehicles. Note that on certain times of the day, vehicles are allowed to deliver products to the stores, in the foreseen zones. Figure 5.22(a) forms a good indication of what the street looks like in practice. It originates from the video that was recorded by professor Rob Van der Bijl.

This case study was chosen due to the fact that Haarlemmerdijk has been getting a lot of attention in the past years because of its high user intensity and the inevitable rising number of conflicts. Incentives rose to divert the 'high speed' passing cyclists to the neighbouring bigger Haarlemmerdijk Houttuinen, which forms a perfect parallel with the street, as can be seen on figure 5.22(b). The incentives found their origin in the ambition of making Haarlemmerdijk (and Haarlemmerstraat in its extension) a nicer and more quiet shopping street. And, in order to be able to accomplish this goal, it is necessary to reduce the bicycle traffic [103]. Nevertheless, meanwhile this project has been ended as a result of budget cuts by the city of Amsterdam [66]. Another reason -for this choice of case study- followed from the qualitative assessments that have been analysed in this master's dissertation; The Netherlands and Amsterdam in specific, are being pushed forward as the fore front of established bicycle systems. Nevertheless, as a result of its success, this high intensity street accommodating two-way cycling, which once was a 'best practice' cycling street, now faces a great challenge on how to distress the bicycle system that has become too busy on Haarlemmerdijk.



(a) Haarlemmerdijk

(b) Situation Google Maps

Figure 5.22: Haarlemmerdijk, Amsterdam

This section will focus on the comparison of three design options that have been suggested by ARCAM Fietslab and a collaboration of designers in 2014 - among which supervisor and professor Rob Van der Bijl, Kees Vernooij and Olv Klijn, these last two have been interviewed in the process of this master's dissertation [100]. Similarly to the case study on the Coupure Links in Ghent, this analysis will happen by using the CROW width label tool.

In the remaining part of this analysis, the total street width from house to house is assumed to be 11.5m. Note that this width corresponds to one specific section and in reality small variations are present over the longitudinal profile. As these will not cause significant differences, this assumption is acceptable. Figure 5.23 visually represents the options.

The first one (5.23(a)) concerns the current design which consists of 4 different zones, from left to right:

- 2.5m pedestrian zone
- 2m multi-functional zone, depending on the longitudinal position in Haarlemmerdijk: Space for bicycle parking or (un-)loading.
- 4.5m street accomodation two-way cycling with a division in the middle. (In this visual representation this equals the two middle zones with a division in the middle.)
- 2.5m of pedestrian zone.

The second design in figure 5.23(b), holds a full width design that is assumed to be open to cycling in two ways. This analysis will have a rather theoretical function.

Lastly, figure 5.23(c) represents a design around a liveable street', where flexible led lightning is a possibility - as was discussed in the theoretical options regarding road space allocation. The design is meant to leave space for the installation of green zones and the installation of terraces by for examples cafes. Here, a width of 2.2m is assumed for cycling in the middle. The consideration of either designing this cycle path in one or two ways will be made during the analysis itself.

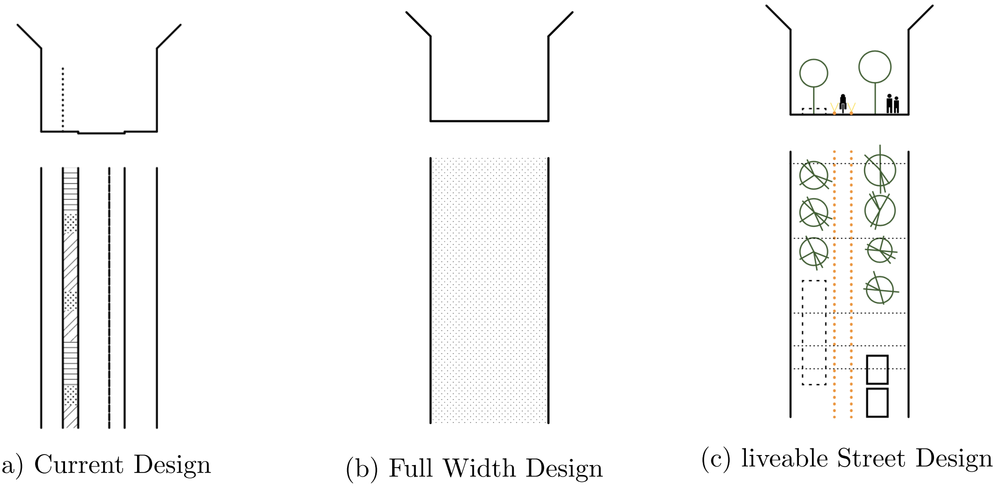

(a) Current Design (b) Full Width Design (c) liveable Street Design

Figure 5.23: Considered design options, Haarlemmerdijk, Amsterdam [100]

Apart from the comparison in capacity and resilience to changes and developments in user composition of the three designs, the current design will be assessed on the influence of temporary obstructions in specific sections. Furthermore, the current configuration of Haarlemmerdijk will be assessed, in detail, on the influence of mopeds with respect to the capacity. The latter types of analyses were included after a site visit to Haarlemmerdijk in Amsterdam. This clearly pointed out these forms of 'misuse' and their noticeable reductions in user comfort.

The CROW-tool will once again be used for these analyses. Furthermore, the considerations and assumptions about the tool that have been made in the dedicated section, are still valid and applied. Note that for this case, the tools from Transport for London and MORE will not be applied because of the conclusions that have been drawn in the previous section. Namely, that they do not yield detailed results with respect to the bicycle system.

5.2.2.1 Availability of Data

As apposed to the case study on the Coupure Links in Ghent, it was not possible to obtain a lot of measurements on Haarlemmerdijk. Nevertheless, data from 2015 was made available by Dick Van Veen, who is working on the current measures that are taken on Haarlemmerdijk and its environment. The data originates from counting on three locations in the surroundings and afterwards extrapolating it, based on previously obtained data of Fietstelweek. More specifically, the dataset was recorded on a Thursday during a working week. [103]

Furthermore, some assumptions have been made during the generation of this data, that will be used in the further analysis. They are summed below.

- During school vacations -10% of these measurements is assumed
- The expected growth towards 2020 for the amount of displacements by bicycle for the whole of Amsterdam is assumed to be +2%
- The latter expansion towards 2025 is assumed to be equal to +4%

Time interval	Amount of cyclists 2015	Assumption 1 2020	Assumption 2 2025
0:00 - 1:00	227	232	236
1:00 - 2:00	122	124	127
2:00 - 3:00	70	71	73
3:00 - 4:00	62	63	65
4:00 - 5:00	53	54	55
5:00 - 6:00	77	79	80
6:00 - 7:00	242	247	252
7:00 - 8:00	653	666	679
8:00 - 9:00	1689	1723	1757
9:00 - 10:00	1268	1293	1319
10:00 - 11:00	933	952	970
11:00 - 12:00	959	978	997
12:00 - 13:00	966	985	1005
13:00 - 14:00	1086	1108	1129
14:00 - 15:00	1088	1110	1132
15:00 - 16:00	1258	1283	1308
16:00 - 17:00	1529	1560	1590
17:00 - 18:00	2168	2211	2255
18:00 - 19:00	2181	2225	2268
19:00 - 20:00	1344	1371	1398
20:00 - 21:00	676	690	703
21:00 - 22:00	609	621	633
22:00 - 23:00	553	564	575
23:00 - 24:00	481	491	500
Sum of the day	20 294	20 699	21 106
Sum of a week	135 293	137 999	140 705
Maximum hourly intensity	**2181**	**2225**	**2268**
Time	18:00-19:00	18:00-19:00	18:00-19:00

Table 5.19: Amount of cyclists Haarlemmerdijk

Table 5.19 represents the data from 2015 that was made available [103] as well as the calculated expectations for 2020 and 2025 that have been assumed.

Nevertheless, as the amount and composition of cyclists changed enormously since 2015, it was chosen to check these assumptions by taking two samples independently. Furthermore, the samples were taken to be able to assess the 'cycling composition' and make qualitative observations during the site visit. The first one concerns a counting of the total amount of cyclists, during a week day on a school break, from 8:00 to 9:00 in the morning. 1454 cyclists were counted. Taking into account an extra 10% for the fact that the measurements were performed on a holiday break, this results in 1599 cyclists. This is scaled towards a hypothetical value during the rush hour by assuming the same ratio between the amount of cyclists between 8:00 and 9:00 and the rush hour 18:00-19:00, as was found in table 5.19. The result is shown in table 5.20.

Total amount of vehicles School holiday Time frame	1454 8:00 - 9:00
Total amount of vehicles Working day Time frame	1599 8:00 - 9:00
Total amount of vehicles **Rush hour working day** Time frame	**2065** 18:00 - 19:00

Table 5.20: Result first sample - Haarlemmerdijk

The second sample concerns a movie of half an hour that was made on a Tuesday (no school holiday) by professor Van der Bijl. It was recorded in order to get a more detailed view of the composition of different types of cyclists as well as on the cycling behaviour. The results are summed in table 5.21. Here, it is assumed that the amount of cyclists in one hour is the double of the half hour recordings. Furthermore, once again this obtained number is scaled towards rush hour, by again, assuming the ratio as found from table 5.19.

Total amount of vehicles Working day Time frame	983 17:00-17:30
Share of wide bicycles	4%
Share of mopeds	1%
Share of fatbikes	2.7%
Amount of cars	10
Amount of heavy load vehicles	1
Total amount of vehicles **Rush hour working day** Time frame	**1977** 18:00-19:00

Table 5.21: Results video sample - Haarlemmerdijk

It is striking that the amount of cyclists obtained from both of the samples is lower than the measured values of 2015. This was not to be expected. It can be the result of the fact that the measurements were performed during a holiday. As a result, the assumption of 10% less cyclists might be questioned. On the other hand, the second sample holds a snapshot of only half an hour, this might be considered as not representative. Furthermore, this second sample was taken in the week after the school holiday, which might still have an influence. Based on the knowledge of professor and supervisor Van der Bijl, who lives in the neighbourhood and frequently cycles on Haarlemmerdijk, the video does not represent the normal situation and the expected amount of cyclists in this time frame.

Nevertheless, the acquiring of the samples was perceived as very valuable to this case study as the practical visualisation highlighted the 'misuse' of Haarlemmerdijk by mopeds as well as a rather high amount of occasional car use and the frequency of loading/unloading. Of the 10 cars that have passed through during the second observation (half an hour), only one was was an emergency service car. As a result of these striking findings, extra analyses have been added to the case study: the effect of temporary hindrances and the effect of mopeds.

5.2.2.2 Current Design

The first step in performing the CROW-width label analysis, consists of determining the effective cycling width B_{eff} of the current design of Haarlemmerdijk. This design follows the configuration and dimensions that were explained by figure 5.23(a). During the site visit, it was established that the kerbs on both sides of the road are lower than 5cm, so no deduction is needed on this end. Nevertheless, a correction is needed in terms of obstacle free space on the right side. In this case, it is assumed that there is only 10cm available due to the proximity of parked bicycles or (un-)loading cars/vans. This assumption is valid as the case study clarified and confirmed the massive amount of parked bicycles. The resulting effective width equals 410cm (equation 5.24).

$$B_{eff} = 450 - (50 - 10) = 410cm \tag{5.4}$$

This value of an effective width corresponds to static width label B (4) according to table 5.1.

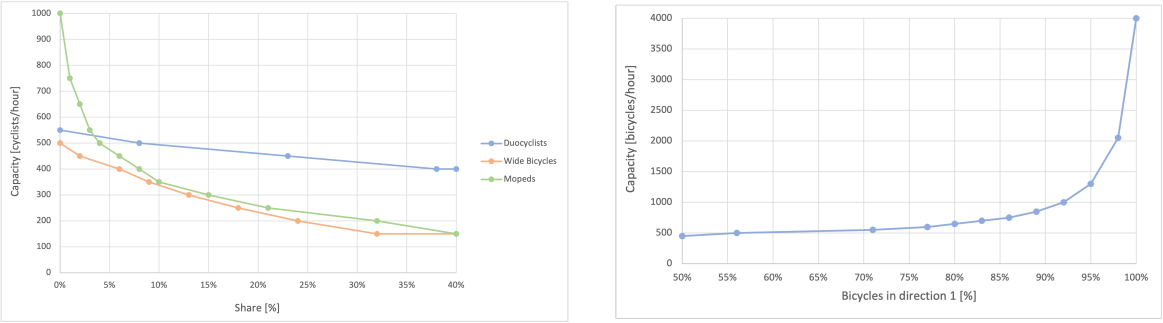
Concerning the further analysis, two specific cases were considered in terms of 'composition' due to the observation of the fact that the moped restriction does not seem to be followed. More specifically, this was decided after the case study on the Coupure Links, as it highlighted the effect of moped share on the width label and more specifically on the amount of hindrances that are expected. All of this resulting in a reduction of the capacity.

The two considered cases both apply the general assumptions of CROW and DTV concerning the share of duocyclists (14%), wide bicycles (1%) and the share of cyclists in the main direction (66% for a two-way cycleway). The difference only lies in the share of mopeds that is assumed:

1. One case does not take into account the influence of mopeds, the share is equal to 0%. Here, it is assumed that the traffic rules are followed.
2. The other case does include mopeds, all sensitivity analyses are calculated according to the general average assumption of DTV and CROW of: a share of 4%.

A similar approach was adapted concerning the range of hourly cycling intensity. The resulting matrices are shown in the appendices for both cases.

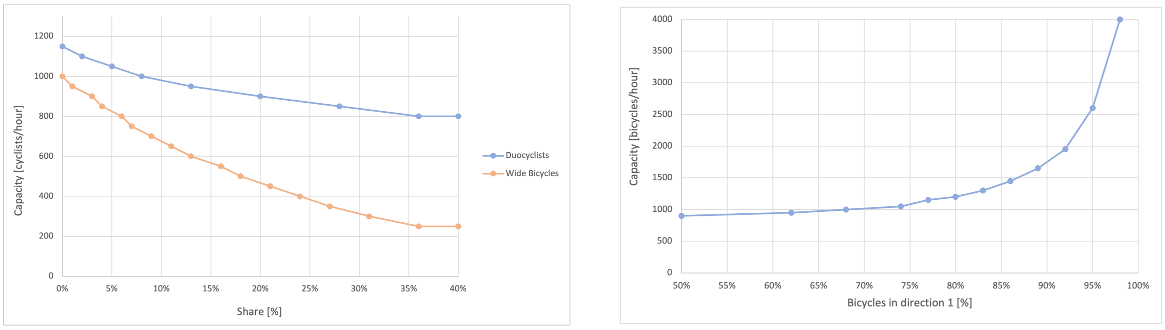
Figures 5.24 and 5.25 respectively represent the capacity lines for the simulations with a share of 4% and 0% of mopeds.



(a) Shares of duocyclists, wide bicycles, mopeds

(b) Share in the main direction

Figure 5.24: Capacity lines - Current design Haarlemmerdijk - 4% of mopeds



(a) Shares of duocyclists, wide bicycles, mopeds

(b) Share in the main direction

Figure 5.25: Capacity lines - Current design Haarlemmerdijk - 0% of mopeds

Taking into account the CROW and DTV assumptions that have been used for the analysis, a capacity of 500 and 950 bicycles/hour was obtained for respectively a share of 4% and 0% of mopeds. This is a 90% difference, which already confirms that the monitoring of mopeds on Haarlemmerdijk is a crucial factor in order to distress the cycling street.

Further general observations and conclusions can be drawn based on the capacity lines and the matrices in the appendices:

- Both cases show a negative effect on the capacity when the share of duocyclists is increased. This is as opposed to the observations that have been made in the case study of the Coupure.
  Nevertheless, when having a look at the matrices provided in the appendices, it strikes the attention that an increase in intensity (exceeding the capacity) shifts this behaviour.
  - In the case where 4% of mopeds were assumed, this shift of behaviour is clearly visible in between an intensity of 900 and 950 bicycles/hour. From this intensity on, an increase of the share of duocyclists, holds positive consequences.
  - Where no mopeds are assumed, this transition line is less clearly defined. Nevertheless, when looking at the transition zone between the orange (label D or 2) and red (label E or 1) zones, or the one between the red and white (label F or 1) zones, a dual behaviour is noticed. Both a very large and a very small share of duocyclists imply a positive effect, while intermediate values result in a negative effect. This negative effect refers to the intensity that can be handled within a specific label.

  As a result, one could say that the influence of the share if duocyclists depends on both:

the share of duocyclists itself and mopeds.

- The share of wide bicycles once again has a negative influence on the capacity. Furthermore, this influence increases when the intensity overtops the capacity. Note that this effect is more outspoken in the case where a share of 0% was assumed
- In both cases, an increase up to 100% of cyclists in the main direction - i.e. making Haarlemmerdijk a one-way street - results in a capacity that exceeds 4000 cyclists/hour. As was mentioned, this value corresponds to the limit of the sensitivity analyses that have been performed. In the case with 0% moped share, this limit was moreover reached at a share of 98% cyclists in the main direction. This means that more slack is available with respect to ghost drivers at this capacity. The same observation is made for all shares that are lower.

Figure 5.26 was added to the analysis, in order to compare the influence on the capacity of duocyclists and wide bicycles, with respect to the share of mopeds, in detail. It immediately strikes that the influence of the two shares is greatly reduced in the case where 4% of mopeds is assumed. The different behaviour is also clearly visible in the matrices that have been generated, especially in the case of wide bicycles. It can be concluded that on moped-free cycleways, the share of wide bicycles will imply the most important consequences. Nevertheless, both shares still show an asymptotic behaviour towards the defined capacity.

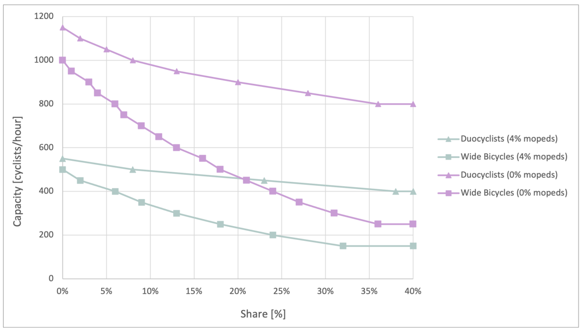


Figure 5.26: Influence moped share on significance duocyclist and wide bicycle shares

Finally, table 5.24 gives on overview of the main results of the analyses on the current design of Haarlemmerdijk.

Design	**Current Design**
Directions	two-way
B	450cm
B_{eff}	410cm
Static width label	B (4)
Capacity - 0% Mopeds	950 bicycles/hour
Capacity - 4% Mopeds	500 bicycles/hour

Table 5.22: Summary current design - Haarlemmerdijk

5.2.2.3 Full Width Design

Secondly, the full width design is assessed by the CROW-width tool. As was mentioned in the introduction, near figure 5.23(b), the full width between the houses is assumed as a two-way cycle path. As a result, the obstacle free width on both sides is equal to 0cm and two reductions of 50cm have to be performed in order to determine the effective width B_{eff}.

$$B_{eff} = 1150 - 50 - 50 = 1050cm \tag{5.5}$$

As a result, the static width label is equal to A or 5, based on table 5.1. Next, again the same parameters have been varied (share of duocyclists, wide bicycles, cyclists in the main direction) for this street accommodating two-way cycling by using the CROW and DTV average values. Concerning the share of mopeds, the analysis was once performed in terms of a 4% share and another time by assuming the 0% share.

Similarly to the results in the case study of Coupure Links where the parking lane was removed, all simulations resulted in a hindrances width label of 5 (A) for hourly intensities up to 4000 bicycles/hour. Intensities higher have not been checked as 4000 bicycles/hour was assumed to be the maximum. Both analyses (4% and 0% moped share) yield the same positive results. Note that the resulting matrices are not included in the appendices due to their monotonous character.

Irrespective of these positive outcomes, it is clear that a full width bicycle street is not achievable due to the purpose of the street. The fact that it holds a shopping street, makes it necessary for people to walk around and thus a pedestrian zone is necessary. Also bicycle parking and space to (un-)load are requirements. Nevertheless, when a comparison with the analysis of the Coupure Links is made, also an effective width of 6m yields a resulting capacity of >4000 bicycles/hour. This design proposition on the other hand, could result in some practically applicable spatial arrangements. This is because still 5.5m is available on the sides. Nevertheless, the remaining width is rather small to include both a pedestrian zone and a bicycle parking zone.

Table 5.23 represents a summary of the results for the full width design on Haarlemmerdijk in Amsterdam.

Design	**Full width design**
Directions	two-way
B	1150cm
B_{eff}	1050cm
Static width label	A (5)
Capacity - 0% Mopeds	> 4000 bicycles/hour
Capacity - 4% Mopeds	> 4000 bicycles/hour

Table 5.23: Summary full width design - Haarlemmerdijk

5.2.2.4 Liveable Street Design

For the liveable street design according to 5.23(c), a width of 220cm was assumed. As was mentioned, practically this could be facilitated by led-lightning. This results in obstacle-free zones on both sides and no kerbs. As a consequence, the effective width B_{eff} of this design is equal to the full width, 220cm. The latter result implies a static width level of B, according to table 5.1.

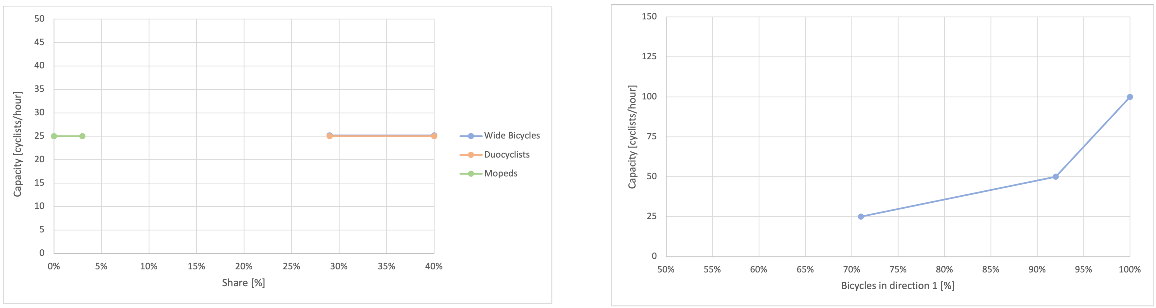
$$B_{eff} = 220cm \tag{5.6}$$

Note that the effective width of 220cm is identical to the effective width that was found in the old design of the Coupure Links. The difference lies in the fact that the Coupure Links was designed as a one-way bicycle path. In this case on Haarlemmerdijk, this has not yet been defined. Nevertheless, it should be noted that due to the dual character and in specific, due to the shops on the street, that in reality, up to some share, it will always be used in two directions.

As a consequence, this analysis will be performed for a two-way path. Like this, the comparison of the previous one-way path analysis at Coupure Links can be made with respect to a new two-way analysis. This could yield insights in the tool as well as enhance making the best design decision.

Once again, the tool is used to check the sensitivity of the capacity when changing the four parameters under the assumption of the average values from CROW and DTV and within the same range of the hourly intensity. Two different cases were checked: one with a 4% moped share and one with a 0% moped share. The extensive results of the analysis in the form of the matrices are once again available in the appendices. Figure 5.27 and 5.28 represent the corresponding capacity lines.

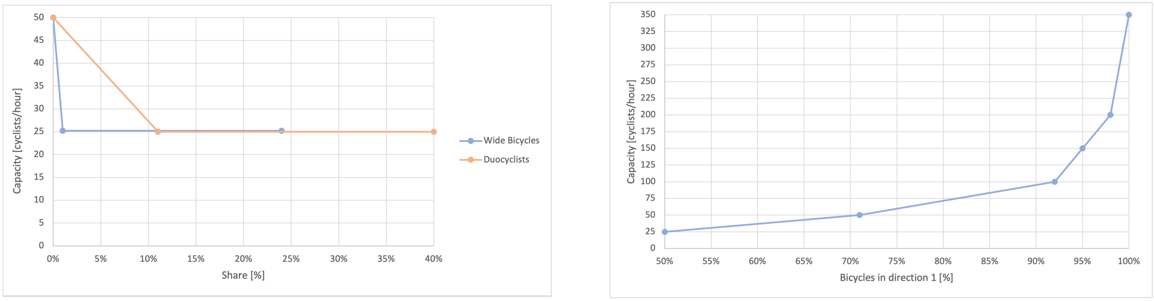
One clear conclusion can immediately be drawn: the capacity of this design is very low. For the average bicycle composition of CROW and DTV with a 4% share of mopeds, the capacity is <25 bicycles/hour. This value was previously defined as a threshold because it corresponds to less than one cyclist per 2 minutes and is not realistic for the considered case studies. Note that the assumption of this threshold, lies at the origin of the discontinuous curves of the capacity lines. Nevertheless, taking into account a moped share of 0%, the threshold capacity of 25 bicycles/hour is reached. This can be drawn from figure 5.27(a) and from figures 5.28(a) and (b).



(a) Shares of duocyclists, wide bicycles, mopeds

(b) Share in the main direction

Figure 5.27: Capacity lines -Liveable street design Haarlemmerdijk - 4% of mopeds



(a) Shares of duocyclists, wide bicycles, mopeds

(b) Share in the main direction

Figure 5.28: Capacity lines -Liveable street design Haarlemmerdijk - 0% of mopeds

Some further observations can be drawn from the matrices and capacity lines:

- Increasing the share of cyclists to 100% corresponds to the same capacity that was found in the case of the one-way cycle path of the Coupure Links, this is a logical result. Respectively 100 and 350 cyclists/hour were found for the 4% and 0% moped share (compared to <25 and 25 cyclists per hour for the two-way design).

- When considering the case with 4% of mopeds, an increasing share of duocyclists results in a positive effect on the capacity. When the intensity exceeds the capacity, the effect remains positive. On the other hand, when looking at the matrices and capacity lines corresponding to the case with 0% mopeds, a decreasing effect is found under increasing share of duocyclists.
  This is a similar observation as was made in the previous analysis: the share of mopeds influences the effect of the share of duocyclists. (But in this case, no dual behaviour is found for the share of duocyclists itself.)
- A high share of wide bicycles has a positive effect on the capacity of the cycleway with an assumption of 4% mopeds. This effect is reversed once the intensity reaches higher values, than a smaller share of wide bicycles is more advantageous. On the contrary, in the case of 0% mopeds, the increase of wide bicycles share only has a negative effect, independent of the intensity.
  Note that this is the first time that a positive influence is observed by the increase of wide bicycles. This observations is somewhat contradictory to what one would expect.
- If the share of cyclists in the main direction becomes smaller than 71% under the assumption of 4% of mopeds, the capacity becomes lower than the considered threshold. Where 0% of mopeds is assumed, a higher resistance to

Design	**Liveable street design**
Directions	two-way
B	220cm
B_{eff}	220cm
Static width label	B (4)
Capacity - 0% Mopeds	25 bicycles/hour
Capacity - 4% Mopeds	< 25 bicycles/hour

Table 5.24: Summary Liveable street design - Haarlemmerdijk

5.2.2.5 Influence of temporary Obstacles

During the site visit to Haarlemmerdijk, it became clear that temporary obstacles form an important hindrance due to the high cycling variety and intensity limiting the available capacity. Therefore, three possible obstacles have been defined for specific sections. They are visually represented in figure 5.29 and are listed below together with the corresponding remaining width of the bicycle street. The latter compared to the actual 450cm of the current street design. Here, it was assumed that a truck has a width of 2.6m and a van/car a width of 2m.

1. A truck is (un)loading on the foreseen parking lane, which is 2m wide. As a result, 60cm of the bulging lorry is taken from the passage for cyclists.
   A remaining width of 390cm is obtained.
2. A truck is (un)loading on the street. Here, it is assumed that the truck cannot use the multi-functional lane because it has to reach a place in front of which bicycle parking is foreseen.
   A remaining width of 190cm is obtained.
3. A van or car is (un)loading on the street because of the same reason as point 2.
   A remaining width of 250cm is obtained.

Figure 5.29: Visual representation of temporary obstacles

Now, the effective width has to be determined of the three cases. For all three, the same principle is applied as on the left side of the street, there is no free space due to the parked vehicle. The other side is considered obstacle free and the kerbs are still assumed to be lower than 5cm.

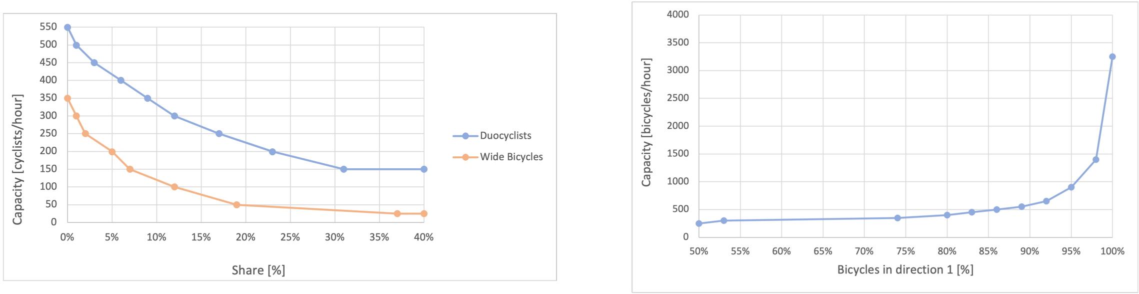
$$B_{eff,1} = 390 - 50 = 340cm \tag{5.7}$$

$$B_{eff,2} = 190 - 50 = 140cm \tag{5.8}$$

$$B_{eff,3} = 250 - 50 = 200cm \tag{5.9}$$

As a result, the static width labels for case 1, 2 and 3 are respectively equal to B, E and D. Only the first obstruction still fulfils the static CROW guidelines. This inherently implies that for the other two cases, the capacity is theoretically undefined. This is because the final width label is always the minimum of the static one and the one derived from the hindrances analysis. As a result the label cannot become higher than respectively E and D, and the transition between label B and C has been defined as the capacity. Nevertheless, the hindrances analysis will still be conducted in other to be able to analyse the influence of the restricted sections.

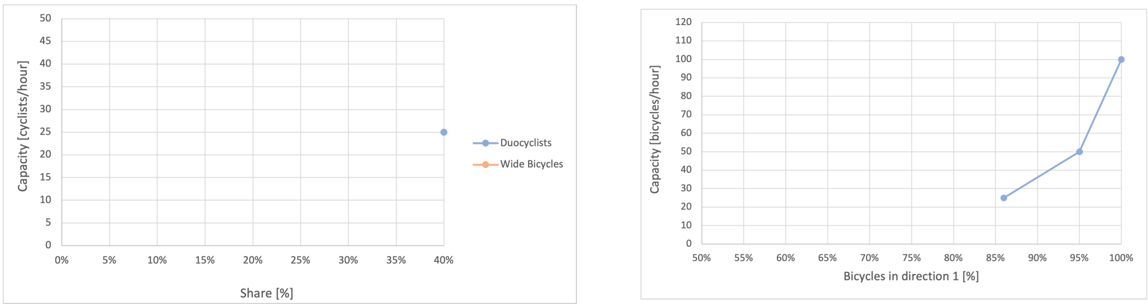
Once again, the tool is used to check the sensitivity of the allowed intensity with respect to the four parameters. The average assumptions of CROW and DTV have been used except for the moped share. The later was taken equal to 0%. This was assumed because the previous analyses pointed out the huge negative impact of the moped share with respect to the capacity. This effect on top of the reduced cross sections would have yielded results that are too low to be analysed. The capacity lines of the three obstacles are given below in figures 5.30, 5.31 and 5.32. The corresponding matrices are provided in the appendices.



(a) Shares of duocyclists, wide bicycles, mopeds

(b) Share in the main direction

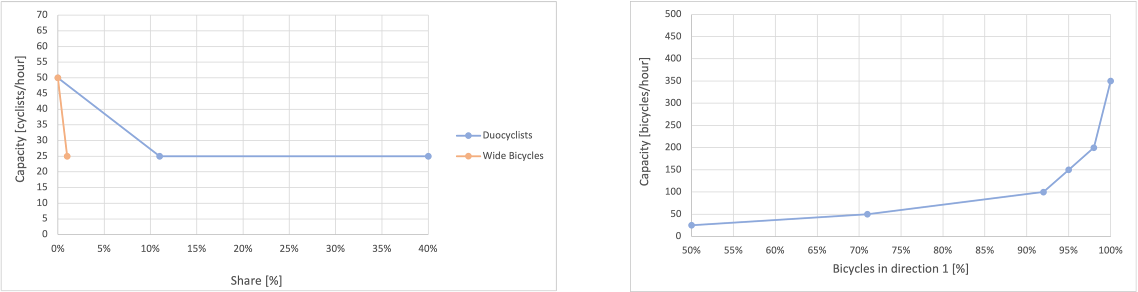
Figure 5.30: Capacity lines - Obstacle 1 Haarlemmerdijk



(a) Shares of duocyclists, wide bicycles, mopeds

(b) Share in the main direction

Figure 5.31: Capacity lines - Obstacle 2 Haarlemmerdijk



(a) Shares of duocyclists, wide bicycles, mopeds (b) Share in the main direction

Figure 5.32: Capacity lines - Obstacle 3 Haarlemmerdijk

From the capacity lines, a capacity of 300, <25 and and 25 bicycles/hour for the three cases respectively. Once again: note that the last two capacities are actually undefined due to the insufficient static width label of the obstructed street.

It is clear that the obstructions hold very big consequences for the available capacities in the specific sections. Again the minimum intensity value of 25 cyclists/hour was assumed. As a consequence, the capacity lines are not defined in some ranges of the share of wide cyclists, duocyclists and bicycles in the main direction. Figure 5.31(a) of the second obstacle is a clear example of that, here the minimum capacity of 25 cyclists/hour is only reached for a share of 40% of duocyclists - under the general CROW assumptions and 0% mopeds. Note that, as was established during the site visit, the moped share is not actually equal to zero due to which an extra negative correction should in practice be performed (on all capacity lines). In terms of cyclists in the main direction, a result is only obtained for a share higher than 86%. This is to be expected as only 1.4m of effective width remains. Subsequently there is not sufficient space available for two cyclists to pass. The first reduction, where a truck is assumed to be parked partly on the road, is the only result were the capacity is defined over all shares that have been analysed. Concerning the third option, with a parked car on the street, it is also clear that not a lot of wide bicycles can be handled in this situation. This result is to be expected.

Note that no further derivations or analysis will be drawn from the results as the influences of different increasing shares are to be expected.

One can conclude that the hypothesis after the site visit was confirmed by the analysis of the CROW width tool: the (un)loading of cars and trucks in Haarlemmerdijk has a big influence on the user comfort and capacity. Table 5.25 provides a summary of the found (theoretical) capacities after the narrowing of different cross sections.

Design	**Current Design - Temporary Obstacles**
Direction	two-way
B_1	390cm
$B_{eff,1}$	340cm
Static width label	B (4)
Capacity - 0% Mopeds	300 bicycles/hour
B_2	190cm
$B_{eff,2}$	140cm
Static width label	E (1)
Capacity - 0% Mopeds	25 bicycles/hour
	theoretically undefined!!
B_3	250cm
$B_{eff,3}$	200cm
Static width label	D (2)
Capacity - 0% Mopeds	<25bicycles/hour
	theoretically undefined!!

Table 5.25: Summary Obstacles - Haarlemmerdijk

5.2.2.6 Comparison of the design options and suggestions

After having completed theoretical analyses for different design options and having checked the sensitivity of the design with respect to mopeds and obstacles, conclusions can be drawn.

Concerning the capacity of the different designs, it is clear that the full width design is the best option as it reaches more than 4000 cyclists/hour. The current design has a capacity of 950 cyclists/hour and the liveable street design of 25 cyclists/hour. But, of course, apart from these numbers, other considerations should be taken into account. The most important one being the dual character of the street: the street is an important destination but also an important travel corridor. This has several consequences for the design options that have been considered:

- The full width design is not realistic as people need to be able to safely walk around and go to the shops.
- The liveable street does not have the capacity to satisfy the cyclists that are passing through.
- Bicycle parking will have to be provided in or around the street for costumers.
- (Un-)loading area will have to be included in the design in order to supply the shop owners.
- A one-way street design is not realistic due to the destination characteristic of the street. In practice, people will come in from all directions.
- Economic concerns will be an important aspect in this case study as the high bicycle passage is a big advantage to the shop owners due to occasional stop-by's of travellers. Nevertheless, this goes beyond the scope of this master's dissertation and will be neglected in this analysis.

Taking into account these requirements, different design suggestions will be made. The design that seems to satisfy all points, is the current design. It leaves space for parking, (un-)loading, walking and it has a high capacity compared to the liveable street option. But in practice, it is clear that this option is not ideal:

First of all, it has been established that the influence of the moped share on this design is very big -reduction from 950 to 500 bicycles/hour for 4% of mopeds. As a result, this misuse cannot be neglected. A solution to this end would be to enforce the moped restriction in a very strict way, for example with smart cameras. Nevertheless, in order to precisely determine the influence of mopeds, consistent monitoring would be a necessity. The second remark that is made with respect to the current design is the vulnerability with respect to vehicles that are (partly) (un-)loading on the street. It has been established in the previous paragraph, that this has a huge consequence on the available capacity. Especially when wide bicycles or mopeds are involved, this becomes problematic. It should be noted, that of course these obstacles are not present for hours at a time or most likely not during rush hours, but nevertheless the increase of dangerous and unpleasant encounters should not be underestimated.

The two remarks that have been made, are not considering the fact that the projected intensity for 2025 is a value of 2268 cyclists/hour. Assuming the best possible situation: no obstacle and no mopeds, a capacity of 950 bicycles/hour is reached. This is only 42% of the assumed effective intensity. When checking the position of this intensity in the matrices, it is found in the red zone with label 1 or E and the white zone with label 0 or F for respectively the simulations with 0% and 4% of mopeds. This means that the cyclists have a very to extremely big chance of dangerous encounters or hindrances and that the capacity is not at all sufficient. Additionally, as was established during the theoretical analysis: this high intensity further enhances the negative effects of wide bicycles and mopeds.

Suggestions are welcome to improve the current design and furthermore, it is clear that the alternative analysed designs will not provide a better alternative when taking into account the requirements. In essence, either a lower intensity or bigger cycleway is needed. The lower intensity alternative can be turned into practice by implementing the original idea by the collaborators from ARCAM Fietslab, namely the diversion of the passing traffic towards the bigger Haarlemmer Houttuinen. Unfortunately, as was mentioned, this project has been turned down [66]. Creating a bigger cycleway, on the other hand, can be done by implementing a number of interventions. In order to do that, the space dedicated to bicycle parking and (un-)loading vehicles has to be designated to active transport. Needless to say, an innovative approach is needed to accommodate this. For the parking spaces an alternative underground parking was thought of as well as the setting up of bicycle parking in different houses along the street. Both solutions imply a ban of parking on the street. Concerning the provision for the shops, a supply system could be set up near the junctions so that trucks don't have to drive on Haarlemmerdijk itself. For the short distance transport from the depot to the shop, cargobikes could be implemented.

Under the condition that extra space is made available by the implementation of these suggestions, alternative solutions can be looked at. A solution that could be implemented would be a 6m wide zone for cyclists, this configuration has already been assessed in the case study of Coupure Links under the general assumptions of CROW and DTV. It corresponds to a capacity of >4000 cyclists/hour without influence of moped share. As a result, no cyclists or mopeds would have to be diverted from the street. Coming back to the liveable street design, it would not be possible to provide this under the assumption that no cyclists would be diverted. Nevertheless, if this would become an opportunity in the future and also mopeds would be diverted to Haarlemmer Houttuinen, the current design could be turned into a liveable street. The place that was dedicated to parking and (un-)loading could now go to a green zone or extra space to set up a terrace for example. In this way, it is assumed that the 950 cyclists/hour is sufficient to cyclists whose destination is Haarlemmerdijk or the neighbouring Haarlemmerstraat.

Note that once again, the definition of capacity according to CROW could be questioned. Nevertheless, during the measurements of the samples and more specifically, while analysing the movements of cyclists in the movie that has been recorded, one could already notice some hindrances, dangerous encounters and necessary deflections. Taking into account that the samples are still 12% less than the projected estimations for 2025, and the observations of professor van der Bijl -who indicated that a normal rush hour is busier than the ones that were observed-one can conclude that the capacity of Haarlemmerdijk is exceeded and might indeed need to be enlarged. On the other hand, the CROW result yields a capacity that equals only half of the cyclists that were counted. This might be considered as a little conservative.

A final remark is that theoretically, similarly to the Coupure Links in Ghent, a further reduction of the capacity should be performed because of the cars that drive through Haarlemmerdijk. This was once again neglected because of the secondary effects. On top of this, also the observed inconsistent cycling behaviour, because of the crowded street, would result in a reduction of capacity. Nevertheless, this was chosen not to be included because the capacity is already very low compared to the measured intensities, due to which it is already clear that interventions have to be performed. Furthermore, this effect on cycling behaviour has not been researched yet.

To conclude, the considered suggestions are summed below under the two assumptions that have been mentioned.

1. The space dedicated to bicycle parking and (un-)loading is designated to active transport.
   - The cycleway is widened in this area, up to 6m effective width.
     A capacity of **more than 4000 cyclists/hour** is obtained.
     No diversion of traffic or moped restrictions are necessary.
2. The passing traffic is diverted and mopeds are banned effectively.
   - The capacity of **950 cyclists/hour** of the current design is assumed to be sufficient for people with destination Haarlemmerdijk.
3. The space dedicated to bicycle parking (un-)loading is designated to active transport AND the passing traffic is diverted and mopeds are banned effectively.
   - Liveable street design: the parking and (un-)loading space of the current design is rearranged towards green zones, terraces, rest areas, etc.
     The cycle lane remains the same.
     The capacity of **950 cyclists/hour** is assumed to be sufficient for people with destination Haarlemmerdijk.

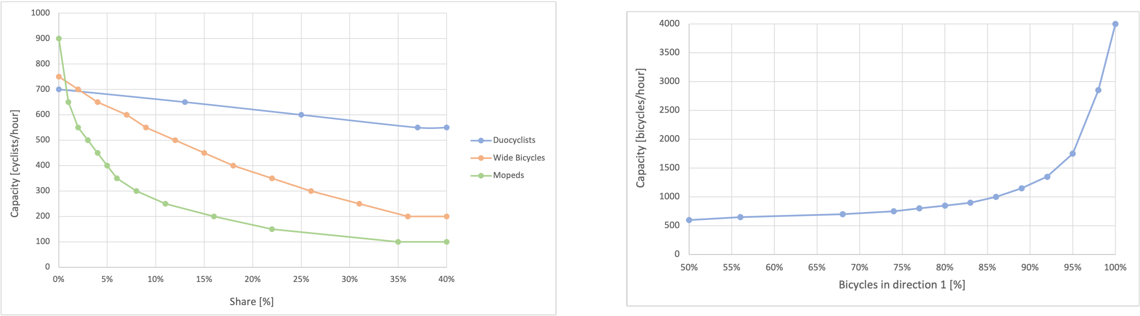
5.2.2.7 Practical application of the sample and interpretation of the results

A final analysis is performed by using the CROW width-tool on the current design of Haarlemmerdijk. This time, the assumptions in table 5.26 will be used as the 'cycling composition' in the model. The shares of mopeds and duocyclists correspond to the ones that were measured when taking the sample. Note that the share of duocyclists has not been quantified by measurements and was thus kept equal to original 14%.

Cyclists in the main direction	66%
Mopeds	1%
Duocyclists	14%
Wide bicycles	4%

Table 5.26: Assumed shares - Practical application Haarlemmerdijk

The resulting matrices of the analysis are presented in the appendices and the capacity lines are given below in figure 5.33. Taking into account the current design of the Haarlemmerdijk and this specific user composition, a capacity of 650 bicycles/hour was found.



(a) Shares of duocyclists, wide bicycles, mopeds

(b) Share in the main direction

Figure 5.33: Capacity lines - Sample application - Haarlemmerdijk

Some general observations are made below.

- When the capacity of 650 cyclists/hour for this case is compared to the matrices of the current design under the CROW and DTV assumptions, a value of 750 cyclists/hour is found for 1% of mopeds. As a result, this difference of 100 cyclists/hour can be dedicated to the wide bicycles that have a 3% higher share in this sample. The same holds for all intensities and moped shares that have been analysed in the matrices.
- The influence of the wide bicycle and duocyclists share as well as the share of bicycles in the main direction on the capacity is similar to what has been observed in the theoretical analysis under the CROW and DTV assumptions.
- The absolute values of intensities that can be handled under the latter parameters' specific share are higher. This was to be expected due to the lower share of mopeds, which was shown to have the biggest influence

When comparing this capacity of 650 cyclists/hour to the measured (and afterwards projected) intensity of 1977 cyclists/hour, it is clear that there is a big gap. Only 33% of the observed intensity is theoretically speaking, able to be handled by the cycleway. As has been mentioned, some hindrances, dangerous encounters and necessary deflections have been observed, but the situation was not perceived as very dangerous. Similarly to the case study on Coupure Links, an overview has been made of the corresponding capacities for this specific case, under the assumption that it would be determined by a different label (see table 5.27). Note that the measured intensity has label F(1) and thus represents a very big change of dangerous encounters or hindrances.

Label as definition	Capacity [cyclists/hour]
A(5)	200
B(4)	650
C(3)	1150
D(2)	1650
E(1)	2100

Table 5.27: Capacities depending on definitions - sample Haarlemmerdijk

Taking into account table 5.27, it strikes that the lowest possible definition of capacity -under the current sample composition- is lower than the value that has been projected to 2025 in table 5.19, namely 2268 cyclists/hour. Even if the capacity would be defined in the least conservative way, it is clear that the current design of Haarlemmerdijk will not be able to facilitate pleasant cycling experience to 2268 cyclists in one hour. It is therefore recommended to consider the proposed interventions.

Once again of the capacity reduction due to the driving cars and because of the deviating cycling behaviour under influence of the crowd, is made. Similarly as before, this is not accounted for in this master's thesis.

Finally, one can conclude that the sample that was conducted on Haarlemmerdijk confirms the theoretical conclusions:

1. According to the CROW width tool, the capacity of Haarlemmerdijk under the current design is not sufficient with respect to the intensities and user composition that have been measured.
2. In reality, a negative correction to the obtained capacity of 650 cyclists/hour should be made in order to take into account the effect of cars in the bicycle street and the deviating cycling behaviour due to the crowded bicycle street.
3. A list of proposed interventions in order to increase the capacity is provided in the previous section.
4. The CROW width tool provides a good indication but might be a little to strict.

5.3 Intermediate Conclusion and Experts' Insights

After taking a closer look into how road space is quantified with respect to the bicycle system, performing two elaborate case studies and listening to the insights of four experts, conclusions can be drawn.

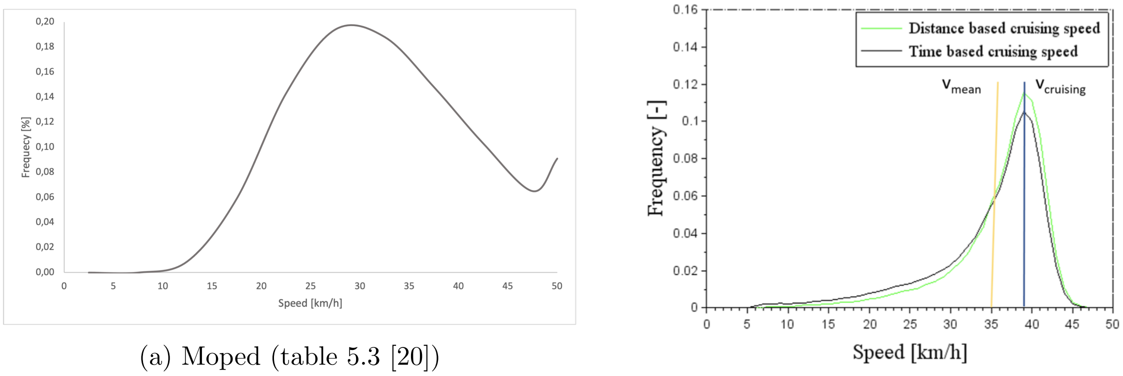
In practice, it is concluded that currently, the most practical and widely spread way to designate space to the bicycle system is by applying static guidelines. This has been confirmed by Fabian Van De Velde and Kees Vernooij who respectively work for the city of Ghent and the city of Amsterdam. Both of them are responsible for the design of bicycle infrastructure and have worked on the Coupure Links and Haarlemmerdijk respectively. Both Kees and Fabian pointed out to make use of the CROW guidelines, furthermore both cities have designed their own policy framework regarding cycling infrastructure. On top of the CROW guidelines, also the guidelines provided in 'Vademecum Fietsvoorzieningen' [111] by the Flemish Government are being used in the city of Ghent [86]. Note that these guidelines have not been outlined in this master's thesis as the last update dates from 2017 and, as was confirmed by Joris Van Damme [87], it is rather outdated with respect to the other contents that have been elaborated in this master's dissertation. Nevertheless, a new version will be published during the summer of 2022. Furthermore, both experts expressed the limits with respect to static guidelines and highlighted that in a lot of cases, they are not applicable or do not result in the outcome that was hoped for. Examples include introducing a bicycle street when the 'necessary' cycling capacity is not reached or the new type of infrastructure that was installed in the Sarphatistraat in Amsterdam. The latter basically entails two one-way bicycle streets separated by a tramway. A speed limit of 30 km/h is adopted to all traffic on this street, except for the tram. Designing bicycle streets according to this approach, drastically reduces the amount of hindrances and dangerous encounters for cyclists, due to which the capacity knows a big increase.

Besides static guidelines, the city of Amsterdam has performed around ten projects by applying 'Desire Line Analysis'. As a result they are the first city to apply this method in such quantities [88]. The purpose of the desire line analyses, according to Kees, ultimately corresponds to picking the low-hanging fruit; assign space that is not used to cyclists, move small obstacles, change road markings such that they correspond to the path that is followed, etc. In general, it is concluded that this method is practically very useful and applicable everywhere: small and big cities, busy and none busy. Even though the resulting measures might not resolve all issues at a busy intersection, they might drastically improve the comfort and safety with respect to cyclists.

Regarding the application or knowledge with respect to the spatial-quantitative tools that have been processed; only Kees had heard of and worked with the CROW-width label tool. Nevertheless, the practical application currently remains nonexistent due to the lack of available space in Amsterdam. The streets are too small in order to implement cycleways with a dimension that corresponds to the suggested width when implementing the measured or assumed intensities in the tool. It is concluded that it holds a meaningful tool with a lot of potential but that it is not designed to be used in a dense urban environment such as Amsterdam.

As for the theoretical case studies, the same difficulty was encountered. Nevertheless, solutions have been proposed with respect to different designs or alternative ways of using the available space. More specifically by applying Lefebvre's 'right to the city' [93], removing the parking spaces and returning the road space to the city's inhabitants to move comfortable and provide them with free space to enjoy themselves. Concerning Haarlemmerdijk, Olv Klijn helped to think of some of the solutions that have been proposed in terms of alternative bicycle parking and distribution centres for the shops [89]. Furthermore, he once again highlighted the unique dual character of Haarlemmerdijk and the possibility to use this case as an experiment of innovative designing. The removal of parking spaces was not only considered on Haarlemmerdijk, but also on Coupure Links in Ghent. Consequently, this option has been presented to Fabian. Apart from being positively surprised by the possible increase of capacity and the resilience of the 6m design with respect to the variance of cyclists and mopeds, he noted that the removal of car parking lanes is a difficult political issue. Nevertheless, this removal is facilitated when there is less than 4m available. Note that in the case of the Coupure Links, a width of 4.1m was established. In using the CROW width tool, this width has been reduced to 3.55m effective width. If, on the contrary, their criteria would have been 4m effective width, the capacity (under the taken sample and calculated based on the CROW width tool) would increase from 150 to 500 cyclists/hour. The latter yields a remarkable increase. To conclude on the parking issue, he shared an example in which hindrance is caused the other way around. In the oldest bicycle street of Ghent; Visserij -which is a similar case as the Coupure Links, it entails a bicycle street on one side of a waterway with a one-way car traffic policy [47]- several complaints have been made against the bicycle street. The reason behind the complaints is the fact that that the street has become too busy for the cars to get in or out of their parking spots. As a result, over time, Stad Gent will have to remove them [86].

When focusing on the sensitivity with respect to the increasing diversity of cyclists, the influence of the increasing share of wide bicycles to the capacity can easily be quantified by using the CROW width label tool. Consequently, appropriate measures are able to be taken when a specific corridor is considered to be (or become) overly stressed, e.g. streets near primary schools. But, note that until now, there has been no discussion about the influence on the capacity by one of the adapted speed profiles that have been calculated for 2025 in the beginning of section 5.2. This is because, for all the analyses on Haarlemmerdijk and the Coupure Links that have been performed, the tool does not provide a distinction when the speed profiles are changed. Even when assuming a very extreme profile, the same results are generated. This seems very counter-intuitive as the wider spread of frequencies in the speed profile should generate larger speed differences between cyclists, and as a result, more encounters are assumed to take place. A larger amount of encounters should lead to a lower capacity.
This unfortunate observation has also been shared with the experts. All of them suggested that this does not correspond to reality and that an adapted speed profile should generate different results. Furthermore, Joris Van Damme referred me to the research of Bram Roetthier. One of his research objectives consisted of determining the speed distribution for the general cruising speed of speedpedelecs [95]. The result is represented in figure 5.34(b). An average speed of 35km/h is found. Nevertheless, one could assume that when the speedpedelec is moving in a crowded urban environment with a speed limit of 30km/h, its average speed will be lower. When this shift is considered, one might find a comparable speed profile to the one that was assumed for mopeds within the DTV and CROW tool 5.34(b). Nevertheless, this alternative interpretation immediately gives rise to another question; the reason why mopeds are considered to cause that much hindrance. The CROW and DTV report does not go into detail about this aspect but refers to the higher speed and the wider dimensions. As a consequence the simplification that is proposed does not generally hold. Nonetheless, during the performed site visit to Amsterdam, the popularity of the electrical fatbike was striking. The dimensions ànd speed of this vehicle are larger than a general bicycle, due to which this simplification with respect to mopeds could hold. It is noted that under this assumption, the current booming of this type of bike holds important implications for the capacity. When the sample measurements are looked at, a similar percentage for mopeds as for fatbikes was noted in Haarlemmerdijk (around 2.7%), on the Coupure Links the share can be neglected.



(a) Moped (table 5.3 [20])

(b) Speedpedelec [95]

Figure 5.34: Assumed Speed Profiles

Now, by summing the 2.5% of mopeds and the 2.7% of fatbikes, a percentage of roughly 5% is found in total. Subsequently, by using the matrices that are provided in the appendices for the sample simulation on Haarlemmerdijk, a reduction of almost 50 bicycles/hour is observed for the capacity, this corresponds to roughly a 30% reduction. Generally, it means that if the defined assumptions are correct, the increase of fatbikes would have the same large negative influence as mopeds on the performed case studies. The effect of general speedpedelecs cannot be defined as there is no information available of the amount of hindrance that is experienced by the mopeds being wide or fast.
In addition, as currently -in theory- the choice to ban mopeds from the cycleways in Amsterdam has already been made, the fatbikes and speedpedelecs are the ones that will result in an increasing stress of the system, as they are still allowed on the cycle paths. Consequently, these type of bicycles will be the ones on which further research and investigations have to be performed.

As a general conclusion of the application with respect to the CROW tool, the point can be made that multi-modal measurements of users and intensities will be of crucial importance in order to make the correct design considerations. These considerations should entail both, the current and future projections. In the case study at Coupure Links in Ghent, a further increase of general cycling is to be expected as the potential is still higher [102]. This lies differently in The Netherlands, here the variety of bikes will increase more than the amount of cyclists, nevertheless, this does not imply that different countries cannot learn from each others' practices and evolution.

With respect to the tools of Transport for London and MORE, one can conclude that they are both useful and can yield as good inspiration sources. Nevertheless, they are less applicable in light of this master's dissertation and to the case studies that have been performed. Furthermore, it might be suggested to imply more parameters that are related to the bicycle system as well as more specific suggestions with respect to cycling.

Lastly, it is noted that all experts are very interested about the outcomes of the research that is ongoing with respect to cycling behaviour and the use of flexible road markings, such as led lights. Part of this interest originates from the realisation that it is not possible to start building new and bigger cycleways with an appropriate capacity in the same way as has been done for cars. First and foremost, cyclists do not react to their environment in the same way as cars, they have a different speed, different reach, are more in contact with environment, etc. On the contrary, the bicycle can form a meaningful connection between pedestrians and car traffic. Treating bicycles like cars would result in losing its character. Furthermore, as Olv Klijn noted it is clear that the bicycle has a lot of potential in European urban environments due to the small scales and interconnection of the city. Secondly, there is not enough space, especially not in urban environments. Thirdly, the problem of conflicts due to the high variety of cyclists is not addressed in this way. According to the experts, the solution lies in appropriate space sharing of different traffic forms. But, as has been established, not enough research has been performed on cycling behaviour and multi-modality in order to propose a viable solution for this moment in time. The latter discussion could result in the rejection of the proposal to create a 6m wide bicycle lane in Haarlemmerdijk and on the Coupure Links. Installing bicycle highways through the city centre would result in treating bicycles like cars.

Apart from this concern with respect to cycling behaviour, also other concerns are raised; with respect to the 'spatial-qualitative' aspect. As has been mentioned this idea is already partly dealt with by the definition of the capacity. Nevertheless, the CROW tool only focuses on links in between intersections and assumes effective use of the cycling facilities. It is clear that in reality, this assumption will not be fulfilled at all times. On top of this, once the facilities become too crowded this might not be a possibility anymore. Consequently, a small spatial-qualitative analysis was made on Haarlemmerdijk based on the video and suggestions that were proposed by promoter and professor Rob Van der Bijl. Figure 5.35 represents a schematic representation of the behaviour that has been observed near the intersection with the Binnen Oranjestraat (where the camera was placed). In essence, four cycle lanes are distinguished in Haarlemmerdijk (A, B, C, D), two in both directions. Furthermore, two lanes are observed side streets, note that also cars are allowed to drive in there. The green and blue lines respectively represent the movements that are made by cyclists to overtake another cyclist, to park their bicycle, etc and crossing movements to turn towards another street.

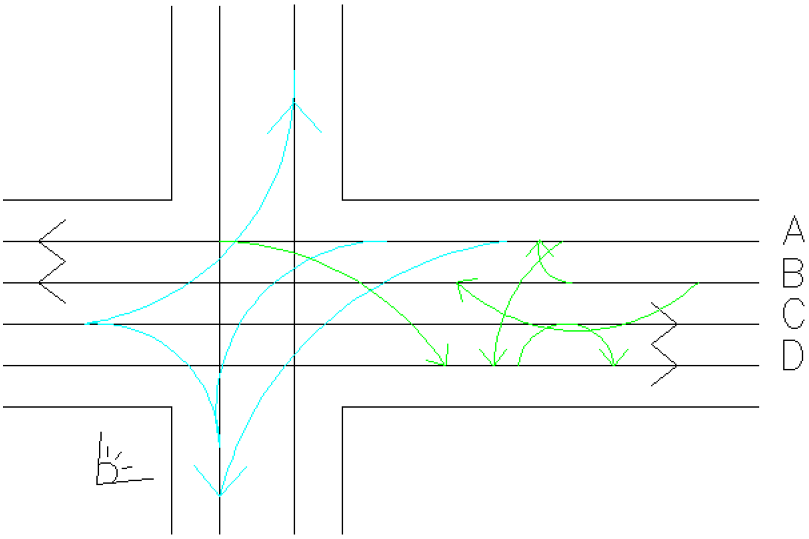


Figure 5.35: Cycling Behaviour Haarlemmerdijk

This sketch clarifies the statement that in reality cyclists do not follow the most effective path. Furthermore, it is clear that both movements to the the connection with another link (blue) and movements because of general cycling behaviour and the place function of Haarlemmerdijk (green) will result in a reduction of the estimated capacity.

Other questions can also be asked with respect to the influence of cycling behaviour on capacity and with respect to spatial-quality:

- How do cyclists react to an intensity that is higher than the capacity or reaching towards the capacity?
    - Will they adapt their speed due to which the capacity is increased?
    - Will they divert to parallel routes due to which the capacity might not be reached?
    - Will they take other actions? e.g. use another mode of transport
- What is the maximum intensity in order for motorised traffic, cyclists and pedestrians to cross a high intensity corridor? Should this be taken into account in the definition of capacity?
- Which intensity is assumed to be appropriate for an important destination street, for example the shopping street in Haarlemmerdijk. Which level of spatial-quality is desired with respect to pedestrians?
- What is the relationship between cycling behaviour and the general network configuration?
- What is the influence of cars in a bicycle street upon cyclists? And how does this affect the spatial-quality and capacity?

To conclude it can be noted that several spatial-quantitative methods are available in order to obtain space to the bicycle system. All of them provide valuable insights. Nevertheless, an integrated tool or method combining behavioural aspects with technical considerations that go beyond simple assumptions and the analyses of one link, is still to be developed.

Chapter 6

Conclusion and Recommendations

The purpose of this master's dissertation consisted of providing a perspective on qualitative and spatial-quantitative assessments of the bicycle system. Originating from a literary review, the current state of assessments has been checked, as well as their resilience towards contemporary developments in the bicycle system. The latter with a focus on the increasing range cyclists composition. Finally, the (practical) knowledge and insights of four Belgian and Dutch experts have been added to the theoretical analysis of this master's dissertation. Consequently, this last chapter will draw general conclusions and recommendations with respect to the discussion. Nevertheless, before this is done, a general remark is made with respect to the references that have been used in this master's dissertation. As was already mentioned in the introduction, the amount of available academic research is limited when it comes to the bicycle system. As a consequence, not all references originate from scientific literature; also practical, operational, policy, technical and journalistic references have been used. Finally, this note can be seen as limitation of the methodology, but also as an incentive to increase the amount of scientifically sustained research of the bicycle system.

Based on the extensive literary review, a definition according to hardware, software, orgware with the inclusion of local context, was chosen to be adopted during this thesis. After half a century long declines in the amount of cyclists, it was noted that cycling has been regaining its popularity. Furthermore, contemporary developments and challenges were identified to be driven by the four components of the quadruple helix; university, industry, civil society and government and institutions. More specifically, the increasing multi-modality of cycling, the integration with different forms of transport modes and the scarcity of space have been highlighted as key developments.

Subsequently, twenty qualitative assessment tools have been analysed. They have been categorised according to ranking, internal and external evaluation tools. Furthermore, each tool has been analysed in detail. The general conclusion holds that there is a need for all encompassing methods that are transparent and openly available.
The recommendations that are made towards the adaptation of existing tools and the design of future methods are the following:

1. Include the full definition of the bicycle system; hardware, orgware, software and context. This is the only way in which the results are representative.
2. Make a clear distinction between the evaluation of the current state, growth over time and ambition in order to get a meaningful ranking.
3. Include the modal split. This parameter represents a clear image on how the cycling climate is established at a certain location, regardless of the cycling facilities that are

available. If possible, include the multi-modality of cycling in this modal split.

4. Concerning cycling facilities; do not solely focus on cycling paths, but take into account space sharing. This is important as cycle paths do not solely form the cycling climate. One the one hand, it has been established that great cycling environments can exist without dedicated cycle paths, but e.g. under the generation of bicycle streets or low speed zones. On the other hand, a lot of cycling paths might be available which are not sufficient and as a result have a negative influence on the cycling climate.
5. Avoid 'bonus points' and keep the focus on objective and transparent parameters. The reader should clearly be able to understand what analyses have been performed and what parameters have been evaluated.

Finally, it has been assessed that the qualitative tools are meaningful. They create added value by bringing attention to the bicycle system and by creating great incentive. Nevertheless, they would become more accurate if the above mentioned recommendations were to be implemented and subsequently, a greater attention would be given to the implications of the contemporary developments that have been identified.

Furthermore, attention was paid to accuracy and objectivity concerning data. In this regard, it was noted that the data, obtained in the assessments that were analysed to define the quality of a system, were often not used in a quantitative way. This absence results in a need towards spatial-quantitative assessments in order to be able to analyse the 'spatial-qualitative' side of the bicycle system.

As a result, the second part of this master's dissertation focused on the spatial-quantitative design of cycleways. A focus was dedicated to four topics; road space allocation based on static guidelines, cycling behaviour, tools and dynamic road space allocation. Afterwards, the methods have been applied to two case studies: Coupure Links in Ghent, Belgium and Haarlemmerdijk in Amsterdam, The Netherlands. The biggest part of this analysis was dedicated to the determination of the capacity of different design options by the application of the CROW width label tool. Again, the results have been discussed with the experts.

In general, the following recommendations are made in the field of road space allocation with respect to cycling and cycleways.

1. Take into account multi-modality with respect to the users of the cycleway, both in interventions and designs. Therefore, it is suggested to perform measurements at locations that are expected to be critical.
2. More research is required with respect to the influence of the increasing amount of fast bicycles on the capacity. Especially type 2 e-bikes should be focused upon.
3. Further research and case studies should be performed with respect to the possibility space sharing. The latter for different combinations and types of traffic. Also the consequences with respect to capacity and design should be identified.
4. The same holds for cycling behaviour in general
5. Design guidelines (static and based on the application of tools) should provide alternative design options to apply in dense urban environments. Note that for this recommendation, the research that has been suggested is necessary.

Regarding the case studies, it can be concluded that the CROW width label tool forms a good method to analyse the expected level of hindrances with respect to the cycling intensity and its composition. In Haarlemmerdijk, it became clear that mainly due to the dual function of the street, the current design cannot maintain the amount of cyclists that are passing everyday. Innovative design solutions are needed in order to clear space or to relocate part of the traffic. It was noted that the proposed interventions will have big economical consequences, but that the quantification of the latter is outside the scope of this master's dissertation. A short term improvement of the situation would be to strictly enforce the ban of mopeds and to include fatbikes into this restriction. For the case of Coupure Links, this same suggestion can be made. On the other hand, the removal of the parking space in both case studies, would result in a big capacity increase and resilience towards the increasing cycling variance. Several design proposals have been enlisted in paragraphs 5.2.1.2.4 and 5.2.2.6 for respectively Coupure Links and Haarlemmerdijk. A general recommendation for the city of Ghent is to change the minimum necessary width for a bicycle street from 4m to 4m effective width. As has been mentioned, considerations have to be made if one were to go forward with this approach. Namely, attention should be payed not to treat cyclists in the same way as cars and that a cycle highway might not be beneficial towards the spatial-quality, especially when the corridor that is considered holds an important destination function.

A final remark with respect to the tool, holds the rather conservative definition of the capacity. This was confirmed after the site visit and the conducting of measurements on Coupure Links. Especially in urban environments, the exact application of the tool is not a possibility due to limited space that is available. Furthermore, as was elaborately discussed in the intermediate conclusion of chapter 5, the tool is a simplified version of reality due to the assumptions with respect to effective cycling behaviour and the focus that is placed on one link. If corrections were to be made for all influences of cycling behaviour that have been summed up in the previous chapter, an even smaller capacity would be left from the already rather conservative assumptions.
To conclude, the CROW width-tool has proven to be a valuable method in order to enhance decision making, apply sensitivity analysis and provide upper and lower boundaries. Nevertheless, the tool should encompass more aspects of cycling behaviour, once research is available in the future. This will help to accurately assess the spatial-quality and capacity of a specific corridor.

Regarding the other tools that have been applied, more cycling inclusive designs and interventions are proposed to be included in the MORE design and intervention tool. Furthermore, it is proposed to use the CROW guidelines instead of NACTO and to include smaller streets in the analysis. The latter recommendation is important in order to be able to accurately apply the tool in cities over Europe, as space is often limited. The tool from Transport for London is complemented on its background, nevertheless a more practically applicable return from the tool would be of added value.

In general, it can be concluded that no clear solution will soon be provided in terms of urban space scarcity in the field of cycling. The same holds for effective strategies to design and enhance the bicycle system in a resilient way with respect to the contemporary developments. Research is still ongoing and is necessary before practical solutions can be suggested. In particular, research with respect to cycling behaviour and the spatial-quality and -quantity of road space will be of great importance in order to sustain and improve bicycle systems in urban environments in Europe. Furthermore, research towards the influence of type 2 e-bikes has to be conducted. The latter should be accompanied with a focus on the multi-modality of cycling in the academic world. As a matter of fact, this multi-modal way of performing measurements as well as an increased focus on the influence of mopeds can already be practically implemented. In the design of new road systems, this can be taken into account. Furthermore, while awaiting the important research of cycling behaviour, the available qualitative assessments could be optimised by implementing the proposed recommendations. Consequently, they can enlarge their impact in rising incentive in countries/cities/municipalities, spread knowledge through all encompassing tools of the bicycle system and help local councils reach the next cycling level.

References

[1] Liz Alderman. ‘corona cycleways’ become the new post-confinement commute. `https://www.nytimes.com/2020/06/12/business/paris-bicycles-commute-coronavirus.html`, 2020.

[2] Dr. Paulo Anciaes. Streetspace allocation option generation tools. `https://ifpedestrians.org/roadoptions/public/policy_objectives`, 2020.

[3] Paulo Anciaes and PM Jones. Tools for generating urban road design options. 2020.

[4] Arup. *FlexKerbs Evolving streets for a driverless future.* Ove Arup Partners, 2018.

[5] Bicycle Policy Audit. Bypad, 2003.

[6] Otto van Boggelen (CROW-Fietsberaad) Bart Veroude (DTV Consultants). Discussienotitie actualisatie aanbevelingen voor de breedte van fietspaden. `https://www.fietsberaad.nl/getmedia/b78e7e99-0c4d-4a66-b7e1-abd595e4913a/Discussienotitie-breedtelabels-voor-fietspaden-april2021.pdf.aspx?ext=.pdf`, 2021.

[7] Hajo Beeckman. Vanaf deze week fietsinformatie in het vrt-verkeersbulletin. `https://www.vrt.be/vrtnws/nl/2021/10/18/vanaf-deze-week-fietsinformatie-in-het-vrt-verkeersbulletin/`, 2021.

[8] Knack Belga. Maar één op de zes belgen gelooft in combimobiliteit als oplossing voor de files. `https://www.knack.be/nieuws/belgie/maar-een-op-de-zes-belgen-gelooft-in-combimobiliteit-als-oplossing-voor-de-files/article-belga-1419067.html`, 2019.

[9] Xiaoyun Zhang (PEEK/Dynniq); Peter Jones Luciano Pana (UCL) Berisha Gelebo, Meng Lu. *Assessment of potential for new technologies.* MORE, 2022.

[10] People For Bikes. City ratings goes global. `https://cityratings.peopleforbikes.org`, 2021.

[11] Elly Blue. *Bikenomics: How bicycling can save the economy.* Microcosm Publishing, 2014.

[12] Thomas Böhmer. The adfc (german cyclist‘s association) bicycle climate test. `https://ecf.com/system/files/ThomasBohmer_VC17presentation.pdf`, 2017.

[13] Elias G. Carayannis and David F. J. Campbell. ’mode 3’ and ’quadruple helix’: toward a 21st century fractal innovation ecosystem. *Int. J. Technol. Manag.*, 46:201–234, 2009.

[14] Interreg Civitas. Sump self-assessment tool. `https://www.sump-assessment.eu/English/start`, 2020.

[15] cma. Coupure links is langste fietsstraat. `https://www.standaard.be/cnt/dmf20190326_04283389`, 2019.

[16] Coenhagenize Design Co. `https://copenhagenizeindex.eu`, 2022.

[17] Copenhagenize EU Design Co. Desire lines analysis – værnedamsvej, copenhagen. `https://copenhagenize.eu/desire-lines-vrnedamsvej`, 2014.

[18] European Commission. Commission recommendation (eu) 2021/1749 of 28 september 2021 on energy efficiency first: from principles to practice — guidelines and examples for its implementation in decision-making in the energy sector and beyond, 2021.

[19] European Commission. Clean transport, urban transport: Cycling. `https://transport.ec.europa.eu/transport-themes/clean-transport-urban-transport/cycling_en`, 2022.

[20] DTV Consultants. Capaciteitsbepaling fietspaden. `https://fietsberaad.nl/Kennisbank/Rapport-Capaciteitsbepaling-Fietspaden`, 2021.

[21] Copenhagenize. The arrogance of space - paris, calgary, tokyo. `http://www.copenhagenize.com/2014/09/the-arrogance-of-space-paris-calgary.html`, 2014.

[22] CROW. Crow platform: Knowledge and information about infrastructural challenges. `https://crowplatform.com/about-crow/`, 2022.

[23] BUUR cvba i.s.m. The New Drive bvba. Vlaamse beleidsvisie mobipunten. 2019.

[24] Joris Van Damme. Joris van damme - over mobiliteit s, m en xl. `https://jorisvandamme.wordpress.com`, 2021.

[25] Hans De Backer. *Wegenbouw I : Geometrische Aspecten*. Ghent University, 2016.

[26] Decisio. Bruto utrechts fietsproduct wat levert een toename van fietsgebruik de stad op? `https://decisio.nl/wp-content/uploads/2017_BUF_rapportage.pdf`, 2017.

[27] Jutta Deffner, Torben Ziel, Tomas Hefter, and CE Rudolph. Handbook on cycling inclusive planning and promotion. *Capacity development material for the multiplier training within the mobile2020 project. Frankfurt/Hamburg*, 2012.

[28] Henk-Jan Dekker. *Cycling Pathways: The Politics and Governance of Dutch Cycling Infrastructure, 1920-2020*. Amsterdam University Press, 2022.

[29] J den Hollander. Level of service audit tool for cycling facilities. In *Australian Institute of Traffic Planning and Management (AITPM) National Conference, 2014, Adelaide, South Australia, Australia*, number 15p, 2014.

[30] Dirk Dufour. Presto cycling policy guide. cycling infrastructure. 2010.

[31] ECF. Presentation of ecf cycling barometer 2015 edition. `https://www.mobilservice.ch/admin/data/files/news_section_file/file/3541/nl5_ecf-barometre-velo2015_en.pdf?lm=1436166648`, 2015.

[32] Eco-Counter. Bicycle growth figures, country per country, city per city. `https://www.eco-counter.com/2019-worldwide-cycling-index/`, 2019.

[33] CIVITAS ELEVATE. Civitas website. `https://civitas.eu`, 2021.

[34] Dutch Cycling Embassy. International city cycling assessment. https://dutchcycling.nl/en/news/news/320-announcing-the-international-city-cycling-assessment, 2019.

[35] Dutch Cycling Embassy. Three bicycle infrastructure manuals inspired by the dutch. https://dutchcycling.nl/en/news/blog/three-bicycle-infrastructure-manuals-inspired-by-the-dutch, 2020.

[36] Dick Ettema. "naar mijn mening is de grootste uitdaging om te begrijpen hoe we steden op een inclusieve, gezonde en duurzame manier toegankelijk kunnen houden.". https://www.uu.nl/medewerkers/DFEttema, 2020.

[37] Interreg North-West Europe. Cycle highway manual. https://cyclehighways.eu, 2022.

[38] Eurovelo. Introducing the first ever eurovelo barometer! https://www.eco-counter.com/blog/introducing-the-first-ever-eurovelo-barometer/, 2019.

[39] FABRICations. Design for better cities - fabrications. https://www.fabrications.nl, 2022.

[40] European Cyclists' Federation. Cyclists love trains: How bike-friendly are europe's rail companies? https://www.youtube.com/watch?v=9RD4T1wTha8&list=TLPQMjUxMDIwMjHkzAg2gAh-ow&index=4, 2021.

[41] Fietsberaad. Advies speedpedelec: meer verkeersveiligheid en behoud concurrentievoordeel. https://fietsberaad.be/documenten/advies-speed-pedelec/, 2020.

[42] Fietsersbond. Fietsstad 2020. https://www.fietsersbond.nl/fietsstad2020/, 2020.

[43] Transport for London. New cycle route quality criteria. https://tfl.gov.uk/corporate/publications-and-reports/cycling, 2019.

[44] Institute for Transportation and Development Policy. The grow cycling toolkit. https://growcycling.itdp.org, 2021.

[45] FUB. Palmarès du baromètre parlons vélo des villes cyclables 2019 : quelques belles progressions, mais une majorité de villes de france ont encore des efforts à faire. https://www.fub.fr/fub/actualites/palmares-barometre-parlons-velo-villes-cyclables-2019-quelques-belles-progressions, 2020.

[46] Institut für Verkehrspädagogik. Bypad – the most efficient method for improving local and regional cycling policy., 2022.

[47] Jan G. De visserij zoals ze nu is, is nu een uithangbord voor het fietsbeleid van de stad gent. https://fietsbult.wordpress.com/2015/03/16/de-visserij/, 2015.

[48] Bill Gates. *How to avoid a climate disaster: the solutions we have and the breakthroughs we need.* Penguin UK, 2021.

[49] Maria Gaton. Ecf cycling barometer. https://ecf.com/resources/cycling-facts-and-figures/ecf-cycling-barometer, 2015.

[50] M Sc Doreen Birte Gehring. Bikeability–index für dresden–wie fahrradfreundlich ist dresden?

[51] Stad Gent. Aanvullend reglement van de politie op het wegverkeer - gemeenteweg - coupure. `https://stad.gent/nl/reglementen/aanvullend-reglement-van-de-politie-op-het-wegverkeer-gemeenteweg-coupure-0`, 2022.

[52] Stad Gent. Nieuwe fiets- en voetgangersonderdoorgang aan coupure geopend. `https://stad.gent/nl/mobiliteit-openbare-werken/nieuws-evenementen/nieuwe-fiets-en-voetgangersonderdoorgang-aan-coupure-geopend`, 2022.

[53] Regine Gerike and John Parkin. Measuring customer satisfaction in bicycle planning and policy: The adfc 'bicycle climate test'. In *Cycling Futures*, pages 281–300. Routledge, 2016.

[54] Charlotte Halpern, Jenny Mcarthur, and Francesco Sarti. *Roadspace reallocation.: Streets as contested spaces.* PhD thesis, Sciences Po, 2020.

[55] Lucas Harms, Luca Bertolini, and Marco Te Brömmelstroet. Performance of municipal cycling policies in medium-sized cities in the netherlands since 2000. *Transport Reviews*, 36(1):134–162, 2016.

[56] Holger Haubold. Is the covid-19 cycling boom real? the numbers say yes! `https://ecf.com/news-and-events/news/covid-19-cycling-boom-real-numbers-say-yes`, 2020.

[57] Holger Haubold. If you build it, they will come: New study shows impact of covid-19 cycling infrastructure. `https://ecf.com/news-and-events/news/if-you-build-it-they-will-come-new-study-shows-impact-covid-19-cycling`, 2021.

[58] Wietse Hermanns. Chips - project summary. `https://www.nweurope.eu/projects/project-search/cycle-highways-innovation-for-smarter-people-transport-and-spatial-plan` 2021.

[59] Serge Hoogendoorn. Allegro: Unravelling slow mode traveling and traffic. `https://www.allegro-erc.nl`, 2020.

[60] Global Designing Cities Initiative. Global street design guide. `https://globaldesigningcities.org/publication/global-street-design-guide#gsdg_collect_datum`, 2016.

[61] Interreg. Smart shared green mobility hubs. `https://www.nweurope.eu/projects/project-search/ehubs-smart-shared-green-mobility-hubs/`, 2022.

[62] Sonja Kahlmeier, Nick Cavill, Hywell Dinsdale, Harry Rutter, T Gotschi, Charlie Foster, and F Racioppi. Health economic assessment tools (heat) for walking and for cycling. 2011.

[63] Sonja Kahlmeier, Thomas Götschi, Nick Cavill, Alberto Castro Fernandez, Christian Brand, David Rojas Rueda, James Woodcock, Paul Kelly, Christoph Lieb, Pekka Oja, et al. Health economic assessment tool (heat) for walking and for cycling: Methods and user guide on physical activity, air pollution, injuries and carbon impact assessments. 2017.

[64] Khashayar Kazemzadeh, Aliaksei Laureshyn, Lena Winslott Hiselius, and Enrico Ronchi. Expanding the scope of the bicycle level-of-service concept: A review of the literature. *Sustainability*, 12(7):2944, 2020.

[65] Sebastian Kraus and Nicolas Koch. Provisional covid-19 infrastructure induces large, rapid increases in cycling. *Proceedings of the National Academy of Sciences*, 118(15), 2021.

[66] Bernard Kroeger. Haarlemmer houttuinen: doorgaande fietsroute vervalt. `https://www.amsterdam.nl/projecten/haarlemmer-houttuinen/`, 2021.

[67] Fabian Küster. Supporting and encouraging cycling in sustainable urban mobility planning. 2019.

[68] Fabian Küster and Benoit Blondel. Calculating the economic benefits of cycling in eu-27. 2013.

[69] Robin Lovelace, Anna Goodman, Rachel Aldred, Nikolai Berkoff, Ali Abbas, and James Woodcock. The propensity to cycle tool: An open source online system for sustainable transport planning. *Journal of transport and land use*, 10(1):505–528, 2017.

[70] Michael B Lowry, Daniel Callister, Maureen Gresham, and Brandon Moore. Assessment of communitywide bikeability with bicycle level of service. *Transportation research record*, 2314(1):41–48, 2012.

[71] Luko. Global bicycle cities index 2022. `https://de.luko.eu/en/advice/guide/bike-index/`, 2022.

[72] Agathe Marie. French cycling barometer 2019: Huge interest and high expectations! `https://ecf.com/news-and-events/news/french-cycling-barometer-2019-huge-interest-and-high-expectations`, 2020.

[73] mkba informatie. Informatie over de mkba voor beginners en experts. `https://www.mkba-informatie.nl`, 2021.

[74] Stichting BOVAG-RAI Mobiliteit. Mobiliteit in cijfers 2021-2022. `https://bovagrai.info/tweewieler/2021/1-6-fietsenpark-schatting/`, 2021.

[75] Modmo. Cities for cyclists: Antwerp, belgium. `https://modmo.io/blogs/news/cities-for-cyclists-antwerp-belgium`, 2021.

[76] Fietsersbond Nederland. Hersenschudding door kinderzitjes en bakfietsgehobbel? `https://www.fietsersbond.nl/de-fiets/accessoires/kinderzitjes/hersenschudding-door-kinderzitjes/`, 2020.

[77] Samuel Nello-Deakin. Is there such a thing as a 'fair'distribution of road space? *Journal of urban design*, 24(5):698–714, 2019.

[78] Manfred Neun, Holger Haubold, et al. The eu cycling economy. arguments for an integrated eu cycling policy. 2016.

[79] Wannes Nimmegeers. Coupure links lijkt op een fietsstraat, maar is het nog niet. `https://www.pzc.nl/gent/coupure-links-lijkt-op-een-fietsstraat-br-maar-is-het-nog-niet~a912cca5/`, 2018.

[80] Ruth Oldenziel. Whose modernism, whose speed? designing mobility for the future, 1880s–1945. *Being Modern: The Impact of Science on Culture in the Early Twentieth Century*, pages 275–289, 2018.

[81] Ruth Oldenziel and Adri Albert de la Bruhèze. Contested spaces: Bicycle lanes in urban europe, 1900-1995. *Transfers*, 1(2):29–49, 2011.

[82] Ruth Oldenziel, Martin Emanuel, Adri A. Albert de la Bruheze, and Frank Veraart. *Cycling Cities: The European Experience: Hundred Years of Policy and Practice*. Foundation for the History of Technology, 2016.

[83] Ruth Oldenziel and Helmuth Trischler. *Cycling and Recycling: Histories of Sustainable Practices*, volume 7. Berghahn Books, 2015.

[84] World Health Organization. Welcome to the health economic assessment tool (heat) for walking and cycling by who. `https://www.heatwalkingcycling.org/#homepage`, 2021.

[85] World Health Organization et al. Riding towards green economy: Cycling and green jobs-a joint report by un environment-who-unece. 2017.

[86] Féline De Pandelaere. Interview fabian van de velde. 2022.

[87] Féline De Pandelaere. Interview joris van damme. 2022.

[88] Féline De Pandelaere. Interview kees vernooij. 2022.

[89] Féline De Pandelaere. Interview olv klijn. 2022.

[90] Lisa De Bode Pieter Van Maele. Groene traagheid werkt stilaan op brusselse zenuwen. `https://www.standaard.be/cnt/dmf20211017_97695900?`
`&articlehash=xJ%2FuO0x0fsm200ZJv%2BRnlLPtZxKTpfdcOklmIuMygmca3AnTi%`
`2BvHsNNoxXyd8fkvxh6c7By64tlSkXtMaru2WARp8izw7RpDerxtLA6O6nOoIzr2LAKTn0lueTSQw%`
`2FqnCYXj3o3j3D72kYEpAgXeQ9qZQIbnXbK3bplJtvac0dt0TaVeyXTqhamfOK3QC9ITSrfhY36IN0jbwvJlAl6`
`2Fs%2FRklIFW8mkQHNfhRQbOvFjWOpO18ngYH2hCf0w5%2BugHwQ%3D%3D`, 2021.

[91] CROW Platform. *Design manual for bicycle traffic*. CROW, 2017.

[92] Paul Plazier. How e bikes impact our mobility - dce, university of groningen, sweco. `https://www.youtube.com/watch?v=RZWVXN251qs`, 2021.

[93] Mark Purcell. Excavating lefebvre: The right to the city and its urban politics of the inhabitant. *GeoJournal*, 58(2):99–108, 2002.

[94] Joey Talbot Robin Lovelace. Rapid cycleway prioritisation tool. `https://www.cyipt.bike/rapid/`, 2021.

[95] Bram Roetthier. Effect of speed pedelecs on planning, designing and building. `https://cyclehighways.eu/fileadmin/user_upload/academies/Presentations/Leuven_10.2018/20181011-CHA5-4a-Bram-SPEEDELECS.pdf`, 2018.

[96] GoDutchCycling RVDB Urban Planning. Hso backgrounds, 2021.

[97] Anna-Lena Scherer. Bicycle industry: Growing at speed. `https://eu.boell.org/en/bicycle-industry-growing-at-speed`, 2021.

[98] Rico Schröter and Peter Dean. Urban corridor road design: Guides, objectives and performance indicators.

[99] BBC World Service. Cycling accross europe in the pandemic. `https://www.youtube.com/watch?v=Cukx_BSQOWw`, 2021.

[100] Bas Driessen FABRIC Jeroen Dijk stadsdeel Centrum Kamiel Klaasse Nl Architects Olv Klijn FABRIC Christiaan Kwantes Coudappel Coffeng Kees Vernooij DRO Amsterdam stefan Bendiks Artgineering, Rob van der Bijl RVDB Urban Planning. Arcam fietslab ontwerpen aan fietsersstromen, 2014.

[101] Frank Van Thillo. Mobiliteitsverslag 2020. `https://publicaties.vlaanderen.be/view-file/38619`, 2020.

[102] Frank Van Thillo. Mobiliteitsverslag 2021. `https://publicaties.vlaanderen.be/view-file/45095`, 2021.

[103] unknown. *Bijlage 4 Tellingen Haarlemmerstraat en -dijk.* Dick Van Veen, 2015.

[104] VAB. Ons fietsgebruik breekt alle records. `https://magazine.vab.be/op-weg/mobiliteit/ons-fietsgebruik-breekt-alle-records/`, 2021.

[105] Rob van der Bijl. De vijf domeinen van de matrix. `https://www.fietscommunity.nl/blogs/de-vijf-domeinen-van-de-matrix/`, 2014.

[106] Rob van der Bijl. Mobility and space - course notes 1 to 7, 2020.

[107] Rob van der Bijl. *Transport poverty scrutinized by mobility thresholds.* Favas, Ghent University, 2020.

[108] Valerie Vanhelden. Spanningen op fietspaden lopen op: hoe conflicten vermijden tussen ”gewone” fietsers, speedpedelecs en bakfietsen? `https://www.vrt.be/vrtnws/nl/2022/05/16/frustratie-fietspaden/?fbclid=IwAR3PP5IM_OU6C9oY4wlX1q1J6YS-G0I8rlJK90asxlpEegpqbeRe_eoxxKs`, 2022.

[109] Vlaamse Stichting Verkeerskunde. Fietsgemeente: wat? `https://www.fietsgemeente.be/wat-2/`, 2022.

[110] Inge Vierth. Modal shift – a way to achieve the environmental objectives. `https://nordicroads.com/modal-shift-a-way-to-achieve-the-environmental-objectives/`, 2019.

[111] Mobiel Vlaanderen. Vademecum fietsvoorzieningen. `https://www.mobielvlaanderen.be/vademecums/vademecumfiets01.php`, 2017.

[112] Parlons Vélo. PalmarÈs des villes cyclables. `https://www.fub.fr/sites/fub/files/fub/Communiques/dossier_de_presse_barometre_bd_11-02-2020.pdf`, 2020.

[113] WeCity. Bike safe – a ranking of the safest cities by people who cycle. `https://www.wecity.it/en/bici-en/bike-safe-ranking-of-the-safest-cities-by-people-who-cycle/`, 2021.

[114] Frank Wefering, Siegfried Rupprecht, Sebastian Bührmann, and Susanne Böhler-Baedeker. Guidelines. developing and implementing a sustainable urban mobility plan. In *Workshop*, page 117, 2013.

[115] Marcel Wiegman. Vanmoof-oprichters taco en ties carlier: ‘winst maken we niet, we woonden tot een half jaar geleden in een huurhuisje’. *Het Parool*, 2021.

[116] Yves. Coupure-links. `https://fietsbult.wordpress.com/2008/05/28/coupure-links/`, 2008.

Appendix A

Summary Qualitative Assessment Tools

Advocacy-based
Institutional/governmental
Companies offering services related to cycling
Independent

QUALITATIVE ASSESSMENTS OF THE BICYCLE SYSTEM

	EXTERNAL EVALUATION	***FOUNDERS***	***Background***
1	**Worldwide Cycling Index**	Eco-Counter	Producer of counters
2	**EuroVelo Barometer**	Eco-Counter, ECF, Eurovelo	Producer of counters + European cycling advocacies
3	**Bicycle Climate Test**	ADFC	German cycling advocacy
4	**Baromètre Parlons Vélo**	FUB	French cycling advocacy
5	**(Rapid) Propensity to Cycling Tool**	UK Universities	Scolars from UK

	INTERNAL EVALUATION		
1	**ICCA**	DCE, Bikeminded, Go Dutch Cycling	Dutch cycling advocacies
2	**Grow Cycling City Toolkit**	ITDF	American cycling advocacy
3	**Cycling Level of Service Assessment**	TfL	Official governmental transport organization London
4	**BYPAD tool**	European Commission	European commission programme
5	**Bicycle Level of Service**	Lowry et al	Scolars
6	**Bikeability Index for Dresden**	Technische Universitat Dresden	Scolars

	RANKING OF BICYCLE SYSTEMS	***FOUNDERS***	***Extra info***
1	**Copenhagenize Index**	Copenhagenize	Copenhagenize Design Co
2	**Global Cities Index**	Luko	German insurance company
3	**Urban Cycling Index**	Wecity	Italian sustainable mobility application
4	**City Ratings**	PeopleForBikes	American cycling advocacy
5	**Cycling Barometer**	ECF	European cycling advocacy
6	**Fietsstadverkiezeing**	Nederlandse fietsersbond	Dutch cycling advocacy
7	**Fietsgemeente**	VSV and fietersbond (be)	Flemish cycling advocacy

SCOPE	***SCALE***	***Differentiation based on city size***	***Inclusion criteria***	***DATA OR INFORMATION SOURCES***	***On site investigations***	***Database source: local/global***
World	Cities	No	#counters	Hard data (counters)	No	Local
EU	Cities	No	#counters	Data from (counters)	No	Local
Germany	Cities	Yes	#respondants in cities	Survey	No	N/A
France	Cities	No	#respondants in cities	Survey	No	N/A
England and Wales	Corridors	N/A	England and Wales	Hard data (sensors) + assumed scenario's	No	Local

SCOPE	***SCALE***	***Differentiation based on city size***	***Inclusion criteria***	***DATA OR INFORMATION SOURCES***	***On site investigations***	***Database source: local/global***
World	Cities	No	On demand	Survey + data	Yes	Local
World	Cities	No	Online Self Assessment	Online survey	No	Local
UK	Corridors	N/A	On demand	Hard data (from project)	Yes	Local
EU	Cities	Yes	On demand	Survey	Yes	Local
?	Grid based	No	Online Self Assessment	Hard data	No	Local
?	Grid based	?	On demand	?	?	?

SCOPE	***SCALE***	***Differentiation based on city size***	***Inclusion criteria***	***DATA OR INFORMATION SOURCES***	***On site investigations***	***Database source: local/global***
World	Cities	Yes	600 fixed cities (+600 000 inhabitants)	Data	No	Global
World	Cities	No	90 fixed cities	Data	No	Global
Italy	Cities	No	18 fixed italian cities	Notions from app users	No	N/A
World	Cities	No (only for threshold of participants)	767 fixed cities (107 in EU)	Network analysis + Survey	No	Local + Global
EU	Countries	N/A	28 EU member states	Data	No	Local + Global
The Netherlands	Cities/towns	No	All Dutch cities and towns	Survey + data	?	Local + Global
Belgium	Cities/towns	Yes	All Flemish cities and towns	Survey + data	Yes	Local

Survey: minimum number of respondants	*QUALITATIVE/QUANTITATIVE*	*TRANSPARENT CALCULATION METHOD/ANALYSIS*	*INVESTIGATED PARAMETERS (AMOUNT)*	*Modal split included*
N/A	Quantitave	Yes	1 (number of bicycles passing counters)	No
N/A	Quantitave	Yes	1 (number of bicycles passing counters)	No
Threshold according to city size	Qualitative	Yes	27 in 5 domains	No
50	Qualitative	Yes	6	No
N/A	Quantitave	Yes	1? (cycling potential?)	No

Survey: minimum number of respondants	*QUALITATIVE/QUANTITATIVE*	*TRANSPARENT CALCULATION METHOD/ANALYSIS*	*INVESTIGATED PARAMETERS (AMOUNT)*	*Modal split included*
N/A? or 1?	Qualitative	Yes	36 in 6 main domains	Yes
N/A	Qualitative	No	17 in 6 domains	No
N/A	Qualitative	Yes	23 in 6 domains	No
2 (internal Bypad and investigated location)	Qualitative	No	?	Yes
N/A	Quantitative	Yes	1 (accessibility)	No
?	Quantitative	?	?	No

Survey: min number of respondants	*QUALITATIVE/QUANTITATIVE*	*TRANSPARENT CALCULATION METHOD*	*INVESTIGATED PARAMETERS (AMOUNT)*	*Modal split included*
N/A	Qualitative	No	13 in 3 domains + bonus category	Yes
N/A	Qualitative	Yes	12 in 6 domains	Yes
?	Qualitative	No	?	?
Threshold according to city size	Quantitative + Qualitative	Yes	10	No
N/A	Quantitative	Yes	5	Yes
50	Quantitative + Qualitative	Yes	9	No
50	Quantitative + Qualitative	Yes	14	Yes

Broad definition of infrastructure	*Focus on current state/growth/ambition/potential*	*Inclusion of HSO*	*Weighting system*	*Inclusion of other forms of tranpsortation*	*Inclusion of cycling benefits*
N/A	Current state + Growth	H	N/A	No	No
N/A	Current state + Growth	H	N/A	No	No
N/A	Current state	H, S, O	No	No	No
yes	Current state + Ambition	H,S,O	No	No	No
No	Potential	H	N/A	No	No

Broad definition of infrastructure	*Focus on current state/growth/ambition/potential*	*Inclusion of HSO*	*Weighting system*	*Inclusion of other forms of tranpsortation*	*Inclusion of cycling benefits*
Yes	Current state	H,S,O	No?	Yes	No
Yes	Current state	H,S,O	No	No	No
No	Current state	H	Yes	Yes	Yes
Yes	Current state	H,S,O	?	?	Yes
No	Current state	H	N/A	No	No
No	Current state	H,S	No	No	No

Infrastructure: focus on cycleways	*Focus on current state/growth/ambition*	*Inclusion of HSO*	*Weighting system*	*Inclusion of other forms of tranpsortation*	*Inclusion of cycling benefits*
?	Current state + Ambition + Growth	H,S,0	No	No	No
No	Current state + Ambition	H,S	No	No	No
No	Current state	/ only safety	N/A	No	No
N/A	Current state	H,S	Yes	Yes	No
N/A	Current state	H,S	No	No	No
Yes	Current state	H,S,0	Yes	No	No
Yes	Current state	H,S,0	No	No	No

Inclusion of networks/accessibility
No
No
Yes
No
Yes

Inclusion of networks/accessibility
Yes
No
Yes
?
Yes
Yes

Inclusion of networks/accessibility	*TOP 5*
No	1) Copenhagen, 2) Amsterdam, 3) Utrecht, 4) Antwerp, 5) Strasbourg
No	1) Utrecht, 2) Munster, 3) Antwerp, 4) Copenhagen, 5) Amsterdam
No	1) Faenza, 2) Grossetto, 3) Cesena, 4) Mantova, 5) Forli
Yes	1) Zwolle, 2) Utrecht, 3) Groningen, 4) Amsterdam, 5) Copenhagen
No	1) Denmark, 2) The Netherlands, 3) Sweden, 4) Finland, 5) Germany
Yes	1) Houten 2) Veenendaal 3) Winterswijk 4) Scherpenzeel 5) Schiermonnikoog
Yes	(A: Big City) Kortrijk (B: Medium City) Deinze (C: Small City) Boechout

Appendix B

Recommendations for Cycling Facilities (MORE)

	Budapest	Constanta	Lisbon	London	Malmö	CROW	Germany	NACTO	Summary
Space Requirements									
Standard Cyclists	1.00 m	No recommendation	0.75 m	1.00 m	0.75 m	0.75 m	1.00 m	0.76 m	0.75–1.00 m
Buffer Dimensions (Recommended, Not Required)									
Between Cyclists	0.00 m	No recommendation	0.50 m	≥ 0.50 m	No recommendation	0.25 m/0.50 m	0.00 m	No recommendation	0.00–≤ 0.50 m
General Traffic	No recommendation	No recommendation	2.50 m to roads with speed limits > 50 km/h 0.70 m to roads with speed limits ≤ 50 km/h	≥ 0.50 m	0.50–1.00 m	1.00 m to roads with speed limits of 50 km/h 0.80 m to roads with speed limits < 50 km/h	0.00 m for on-carriageway cycle facilities 0.50–0.75 m for cycle facilities alongside the carriageway	No recommendation	0.00–2.50 m depending on position of cyclists and speed limit
Pedestrians	-	-	-	-	0.30–0.40 m	-	0.00 m for on-carriageway cycle facilities 0.25 m for cycle facilities alongside the carriageway	No recommendation	0.00–0.40 m
Obstacles	0.25 m to kerbs, 0.35 m to obstacles on bridges and in exceptions 0.50 m to other obstacles	No recommendation	0.20 m to obstacles < 0.15 m e.g. kerbs, drainage grids 0.30 m to obstacles from 0.15 m to 0.90 m e.g. benches, railings, fences, 0.30–0.60 m to obstacles > 0.90 m e.g. traffic signs, public lighting 0.60 m to obstacles > 0.90 m e.g. bus stop shelters, trees 0.90–1.20 m to build elements e.g. walls, facades	≥ 0.50 m	No recommendation	0.25 m to obstacles < 0.05 m e.g. kerbs 0.50 m to obstacles > 0.05 m e.g. kerbs 0.70 m to fixed object e.g. railings, lamp posts, traffic signs, trees 1.00 m to build elements e.g. walls, facades (Measures exclude space requirements of cyclists)	0.25 m to e.g. walls, trees, traffic signs	No recommendation	0.20–1.20 m depending on obstacle height and type
Parking/ Loading	0.80 m	No recommendation	0.70 m	≥ 0.50 m	0.80–1.00 m (where stopping is allowed)	0.50 m	- 0.25–0.75 m to longitudinal parking for on-carriageway cycle facilities - 0.75 m in any other case	No recommendation	0.25–1.00 m depending on parking angle
Other	-	-	0.70 m to watersides	-	-	-	-	-	

(Table continued on following page)

	Budapest	Constanta	Lisbon	London	Malmö	CROW	Germany	NACTO	Summary
Application of Cycling Infrastructure									
Criteria	v & SL	None	v & SL & street type	v* & 85th percentile speed & street type	Network function & v*	v & SL & c & number of lanes	v* & SL	v & SL	v & SL (& street type)
Mixed Traffic	v ≤ 4,000 and SL ≤ 30 or v ≤ 2,000 and SL ≤ 50	Generally applied	v ≤ 3,000 and SL ≤ 30 (Local street)	v ≤ 10,000 and 85th percentile speed ≤ 48 At Local streets, High streets, Town squares, City hubs, City streets, City places (bicycle street: analogous)	In residential network with v ≤ 3,000	v ≤ 5,000 and SL ≤ 30 and c ≤ 2500 bicycle street: SL = 30 km/h, c > v, c ≥ 500 and/or v ≤ 2,500	v < 8,000 and SL = 30 or v < 4,000 and SL = 50 or v < 2,000 and SL = 70 with additional non-mandatory off carriageway facility: see criteria of advisory cycle lanes (bicycle street: SL ≤ 30 km/h)	Not recommended	Up to v = 10,000 or Up to SL = 70
Advisory Cycle Lane	v > 6,000 and SL ≤ 30 or v > 5,000 and SL ≤ 40 or v > 4,000 and SL ≤ 50	Not recommended	Not recommended	At Connectors, Local streets, High roads, High streets, Town squares, City hubs, City streets	Not recommended	Not recommended	v < 18,000 and SL = 30 or 4,000 < v ≤ 10,000 and SL = 50 or v < 3,000 and SL = 70	Not recommended	Up to v = 18,000 or Up to SL = 70
Mandatory Cycle Lane	v > 6,000 and SL ≤ 40 or v ≤ 4,000 and SL ≤ 50	No recommendation	3.000 < v ≤ 8.000 and SL = 50 (Local street)	At Arterial roads, Connector roads, High roads, High streets, City hubs	Not recommended	v ≤ 2,000 and SL ≤ 30 and c ≥ 2000 or v ≤ 4,000 and SL ≤ 30 and c < 750 or SL = 50 and c < 75 (2-lane carriageway)	v > 18,000 and SL = 30 or v > 10,000 and SL = 50 or v > 3,000 and SL = 70	v ≤ 3.000 SL ≤ 40	Up to v = 18,000 or Up to SL = 70
Segregated Lane/Stepped track	v > 15,000 and SL ≤ 40) or v > 8,000 and SL ≤ 60	No recommendation	3.000 < v ≤ 10.000 and SL = 50 (Distributional street)	Minimum: light segregation with v > 10,000	Not recommended	Not recommended	Not recommended	No recommendation	From v = 3,000 or From SL = 40
Bus/Cycle Lane	No recommendation	No recommendation	No recommendation (has not been implemented yet)	Connectors, Local streets, High roads, High streets, Town squares, City hubs, City streets	Not recommended	Not recommended	SL ≤ 50	Not recommended	-
Cycle Track/Path	> 8,000 and SL > 60 also used with lower SL	No recommendation	3.000 < v ≤ 8.000 and SL = 50 (Local street) or v > 10.000 and SL ≥ 50 (distributional or structural street)	Arterial roads, Connector roads, High roads	Anywhere in main network (standard solution: bidirectional)	SL ≥ 50or v ≥ 2,000 and SL ≤ 30 and c > 2000 or v ≤ 4,000 and SL ≤ 30	v > 18,000 and SL = 30 or v > 10,000 with SL = 50 or v > 3,000 and SL = 70	No recommendation	From v = 2,000 or From SL = 30

Volume of motorised traffic v [vehicles/ 24 h]; speed limit of motorised traffic SL [km/ h]; volume of cyclists c [cyclists/24h];* Where volumes v are defined in veh/h. The daily volume is tenfold the volume/hour.

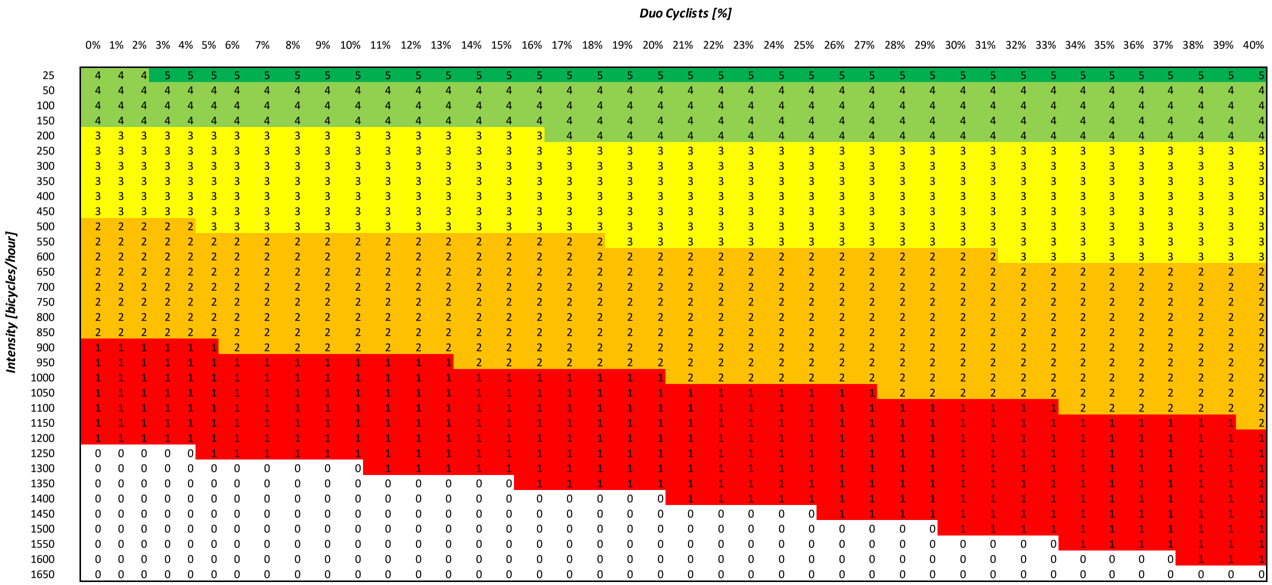
(Table continued on following page)

	Budapest	Constanta	Lisbon	London	Malmö	CROW	Germany	NACTO	Summary
Width of Cycling Infrastructure									
Mixed Traffic	3.50–4.50 m lane width (depending on speed limit and design vehicle)	No recommendation	3.80 m lane width if adjacent building high < 5 floors 4.50 m lane width if adjacent building high ≥ 5 floors	≤ 3.20 m lane width or ≥ 4.00 m lane width (no operational criteria)	5.50 m carriageway width	5.80 m carriageway width c' ≤ 100 or v' ≤ 200 and c' ≤ 400	≤ 6.00 m carriageway width v' ≤ 500 ≥ 7.00 m carriageway width v' ≤ 1,000	-	≤ 3.20 m or ≥ 4.00 m lane width (Avoid medium values)
Advisory Cycle Lane	1.25 m Min. 3.5 m remaining carriageway width	-	-	≥ 2.00 m	-	-	1.50 m Min. 4.5 m remaining carriageway width	-	1.25–2.00 m with recommendations on remaining carriageway width
Mandatory Cycle Lane	1.25 m	≥ 1.00 m	≥ 1.50 m	≥ 2.00 m	-	2.00–2.25 m	≥ 1.85 m	1.83 m	1.25–2.25 m
Bus/Cycle Lane	4.25 m	-	3.20–3.25 m	3.00–3.20 m with ≤ 20 buses/hour or ≤ 100 buses and taxis per hour ≥ 4.50 m with > 20 buses/hour or > 100 buses and taxis per hour	-	-	3.00–3.50 m with c ≤ 200 ≥ 4.75 m with c > 200	-	3.00–3.50 m or ≥ 4.25 m
Cycle Track One-Way	2.00 m	≥ 1.00 m	≥ 1.50 m	≥ 1.50 m	≥ 1.50 m	2.00–4.00 m	2.00 m	1.99 m	1.50–4.00 m
Cycle Track Two-Way	2.50 m	≥ 2.00 m	≥ 2.60 m	≥ 2.0 m	2.50–3.50 m	2.50–4.50 m	2.50 m	3.66 m	2.50–4.50 m
Cycleway	-	-	≥ 2.60 m	1.20–3.50 m	-	-	2.50–4.00 m	-	1.20–4.00 m
Mixing and Segregating Cyclists and Pedestrians									
Criteria for Shared Facility	ca. 60–420 ped/h and ca. 60–420 cyclists/h	Not recommended	max 250 ped/h	Alongside the carriageway: to avoid Off-road: preferred for all traffic situations	Not recommended	max 250 ped/h/m of profile width	Only where separated provision cannot be used Max 1/3 cyclists in total volume of pedestrians + cyclists	Not recommended	Acceptable with low volumes of pedestrians and cyclists
Width of Shared Facility	3.50–4.25 m	-	2.70–3.00 m	2.20–4.50 m	-	No recommendation	> 2.50 m	-	2.20–4.50 m
References									
	(MAUT, 2005, 2019)	(Institutul Roman de Standardizare, 2010)	(Municipal Chamber of Lisbon, 2018)	(Transport for London, 2016a)	(City of Malmö - Streets and Parks Department, 2006, 2010a, 2019; City of Malmö: Brodde Makri, Maria and Nordlund, 2019)	(CROW, 2016)	(FGSV, 2006, 2010)	(National Association of City Transportation Officials, 2014)	

Volume of motorised traffic v' [vehicles/ h]; volume of cyclists c' [cyclists/ h]

Appendix C

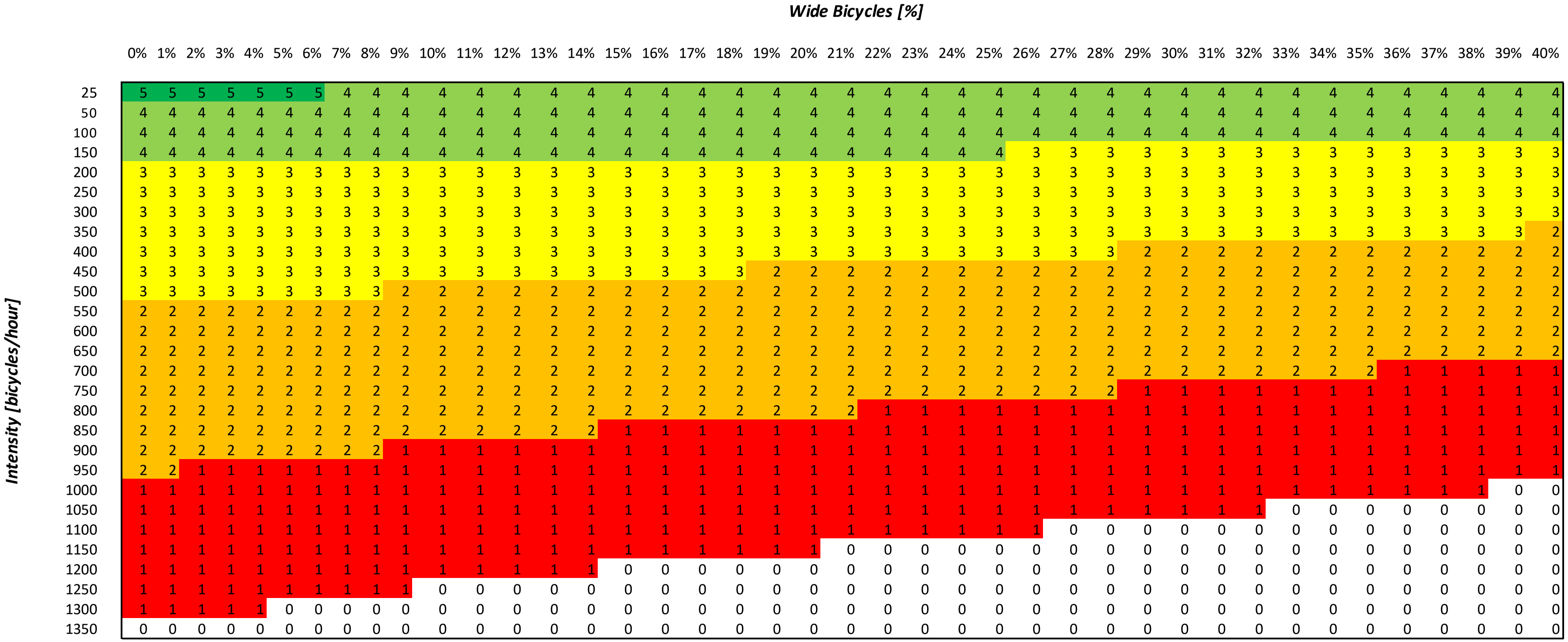
Matrices: Coupure Links - Current Design



Duo Cyclists [%]

Intensity [bicycles/hour]

	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
50	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
100	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
150	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
200	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
250	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
300	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
350	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
400	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
450	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
500	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
550	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
600	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3
650	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
700	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
750	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
800	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
850	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
900	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
950	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1050	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2
1100	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
1150	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
1200	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1250	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1300	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
1550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
1600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
1650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

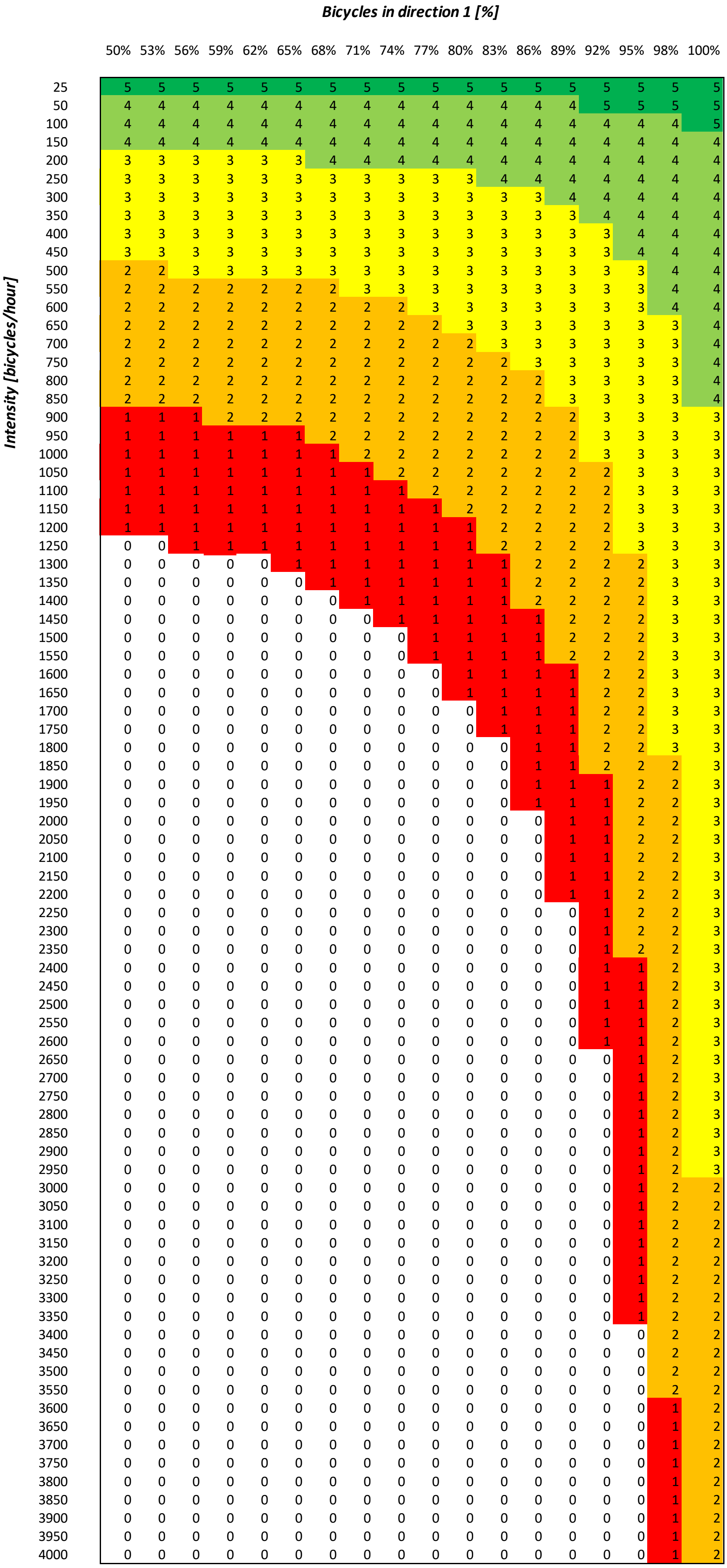


Wide Bicycles [%]

Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
50	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
100	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
150	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
200	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
250	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
300	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
350	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
400	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2
450	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
500	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
550	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
600	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
650	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
700	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1
750	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
800	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
850	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
900	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
950	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
1050	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
1100	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1150	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1200	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1250	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1300	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Mopeds [%]

Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
50	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
100	5	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2
150	5	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
200	5	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
250	5	4	4	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
300	5	4	4	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
350	4	4	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
400	4	4	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
450	4	4	3	3	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
500	4	3	3	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
550	4	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
600	4	3	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
650	4	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
700	4	3	3	2	2	2	2	2	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
750	4	3	3	2	2	2	2	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
800	4	3	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
850	3	3	2	2	2	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
900	3	3	2	2	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
950	3	3	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1000	3	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1050	3	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1100	3	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1150	3	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1200	3	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1250	3	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1300	3	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1350	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1400	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1450	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1500	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1550	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1600	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1650	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1700	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1750	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1800	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1850	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1900	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1950	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2050	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2100	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2150	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2200	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2250	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2300	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2350	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2400	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2450	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

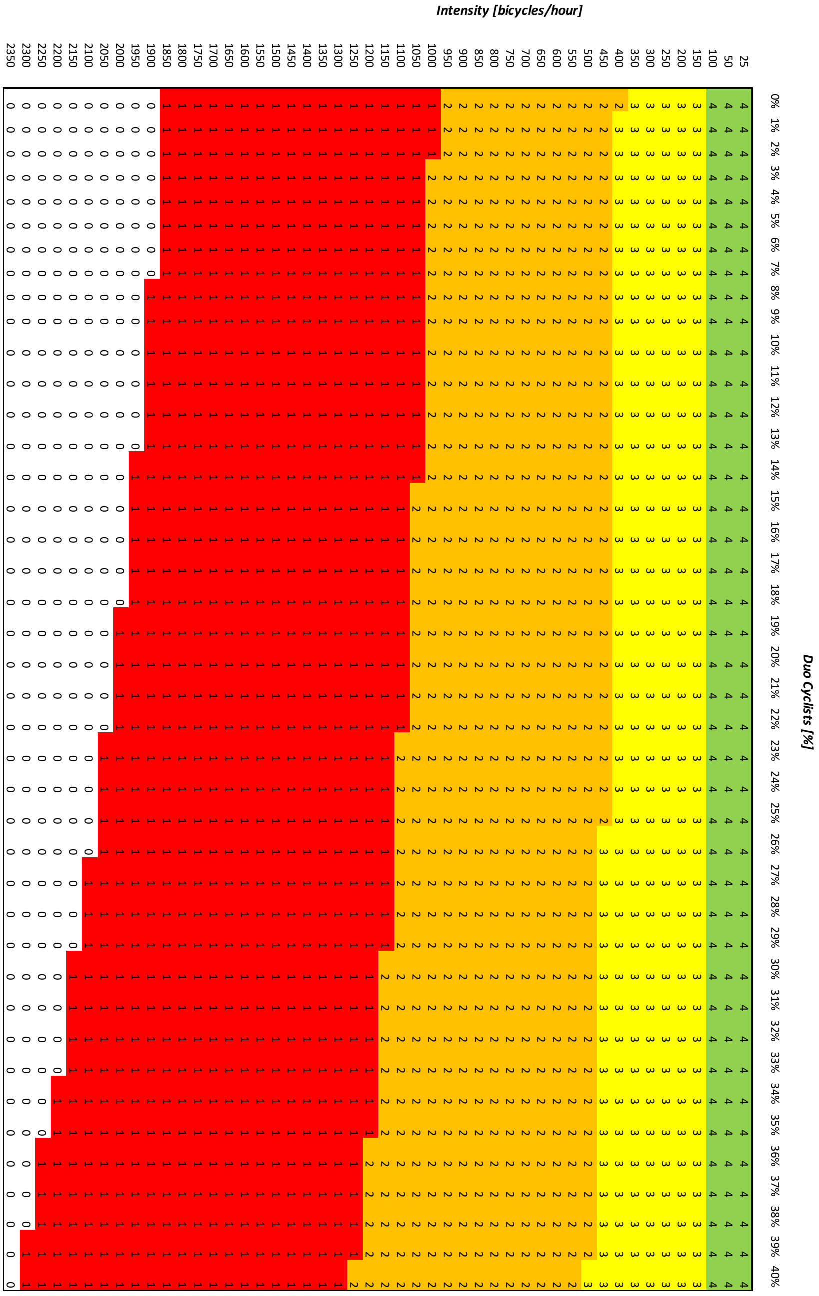


Bicycles in direction 1 [%]

Intensity [bicycles/hour]	50%	53%	56%	59%	62%	65%	68%	71%	74%	77%	80%	83%	86%	89%	92%	95%	98%	100%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
50	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5
100	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5
150	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
200	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4
250	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4
300	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4
350	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4
400	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4
450	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4
500	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4
550	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4
600	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4
650	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4
700	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4
750	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4
800	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4
850	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4
900	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
950	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3
1000	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3
1050	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3
1100	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3
1150	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3
1200	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3
1250	0	0	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3
1300	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	3	3
1350	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	3	3
1400	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2	2	3	3
1450	0	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3	3
1500	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
1550	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
1600	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	3
1650	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	3
1700	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3
1750	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3
1800	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3
1850	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	2	3
1900	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3
1950	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
2050	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
2100	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
2150	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
2200	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
2250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3
2350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3
2400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
2450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
2500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
2550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
2600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
2650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
2700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
2750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
2800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
2850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
2900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
2950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
3450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
3500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
3550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
3600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
4000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2

Appendix D

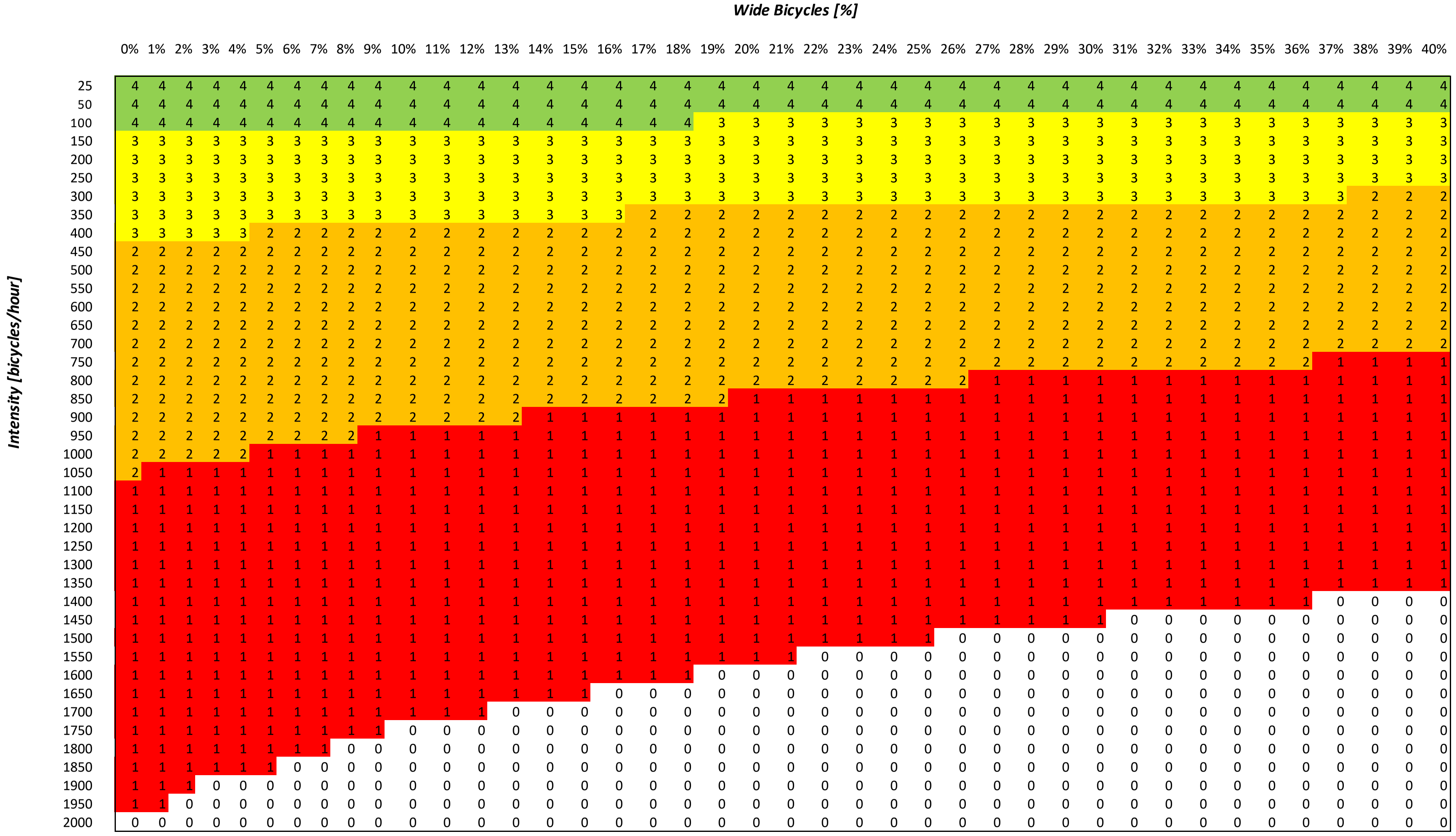
Matrices: Coupure Links - Previous Design



Intensity [bicycles/hour]

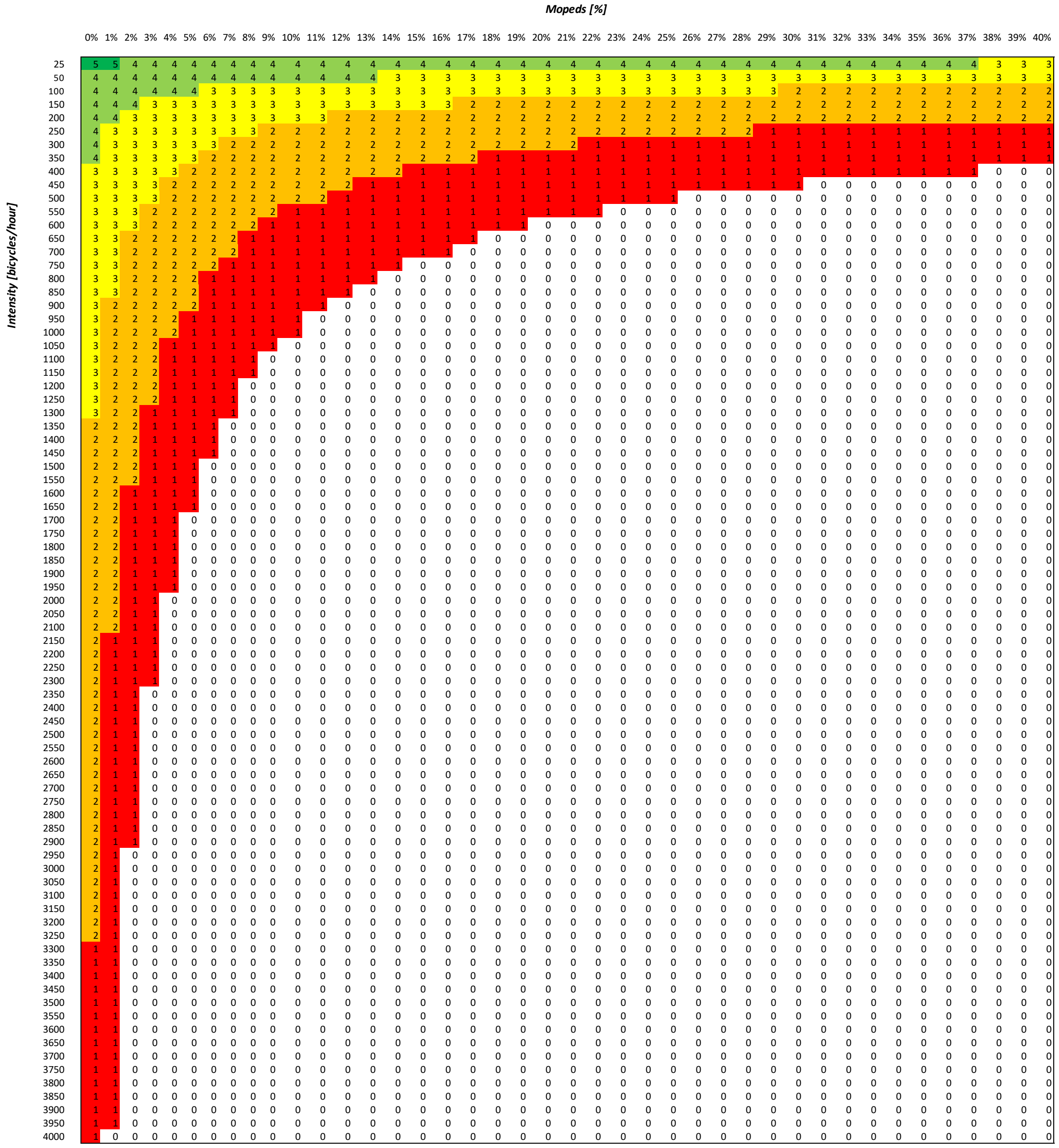
Duo Cyclists [%]

	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
50	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
100	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
150	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
200	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
250	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
300	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
350	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
400	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
450	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
500	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3
550	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
600	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
650	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
700	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
750	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
800	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
850	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
900	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
950	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1000	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1050	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1100	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1150	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2
1200	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
1250	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
1300	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1350	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1400	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1450	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1550	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1600	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1650	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1700	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1750	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1800	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1850	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1900	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
2200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
2250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



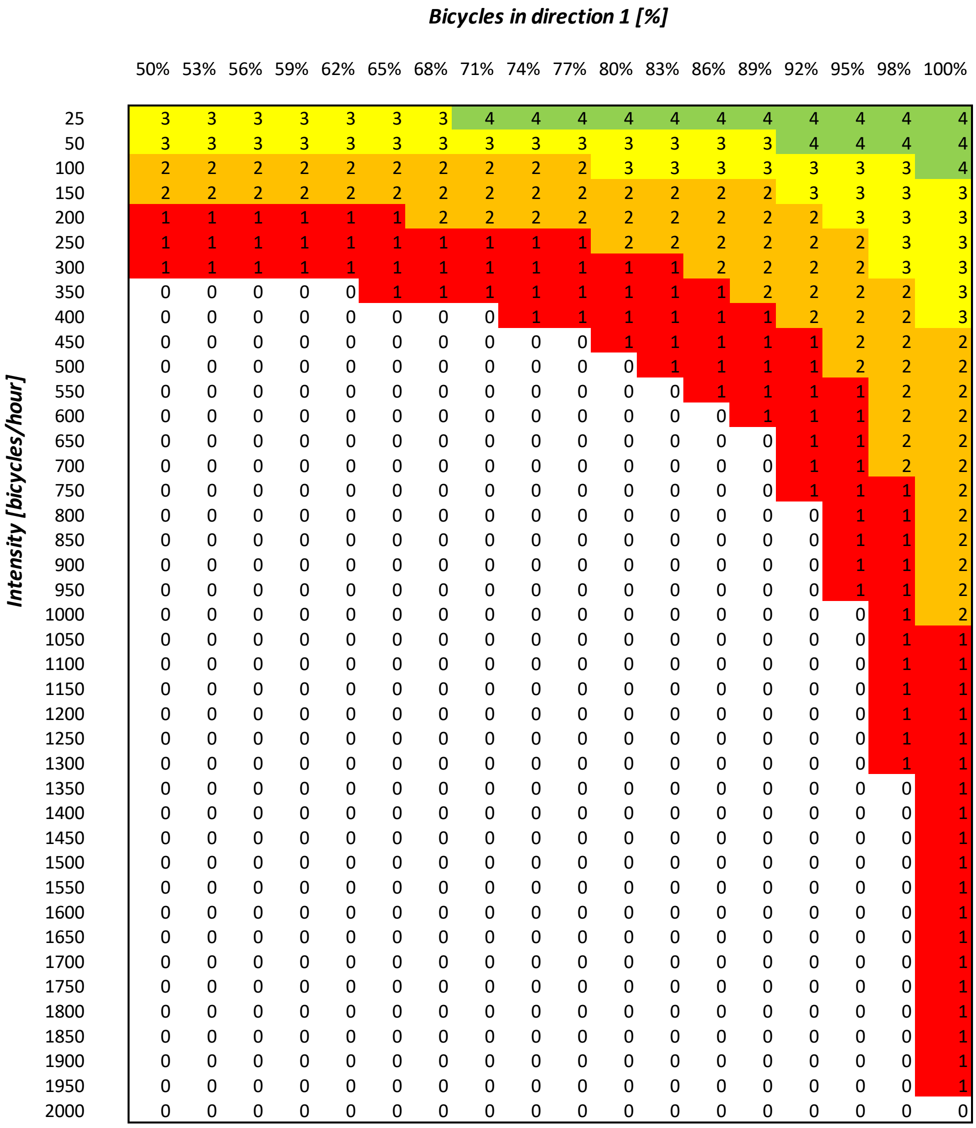
Wide Bicycles [%]

Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
50	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
100	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
150	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
200	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
250	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
300	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
350	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
400	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
450	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
500	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
550	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
600	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
650	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
700	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
750	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1
800	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
850	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
900	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
950	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1000	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1050	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1100	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1150	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1200	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1250	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1300	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1350	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1400	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
1450	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
1500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1550	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1600	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1650	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1700	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1750	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1800	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1850	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1900	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1950	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Mopeds [%]

Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3
50	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
100	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
150	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
200	4	4	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
250	4	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
300	4	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
350	4	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
400	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
450	3	3	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
500	3	3	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
550	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
600	3	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
650	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
700	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
750	3	3	2	2	2	2	2	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
800	3	3	2	2	2	2	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
850	3	3	2	2	2	2	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
900	3	2	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
950	3	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1000	3	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1050	3	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1100	3	2	2	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1150	3	2	2	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1200	3	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1250	3	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1300	3	2	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1350	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1400	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1450	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1500	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1550	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1600	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1650	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1700	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1750	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1800	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1850	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1900	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1950	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2050	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2100	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2150	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2200	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2250	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2300	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2350	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2400	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2450	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2500	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2550	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2600	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2650	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2700	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2750	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2800	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2850	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2900	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2950	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3000	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3050	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3100	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3150	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3200	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3250	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3300	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3350	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3400	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3450	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3500	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3550	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3600	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3650	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3700	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3750	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3800	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3850	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3900	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3950	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



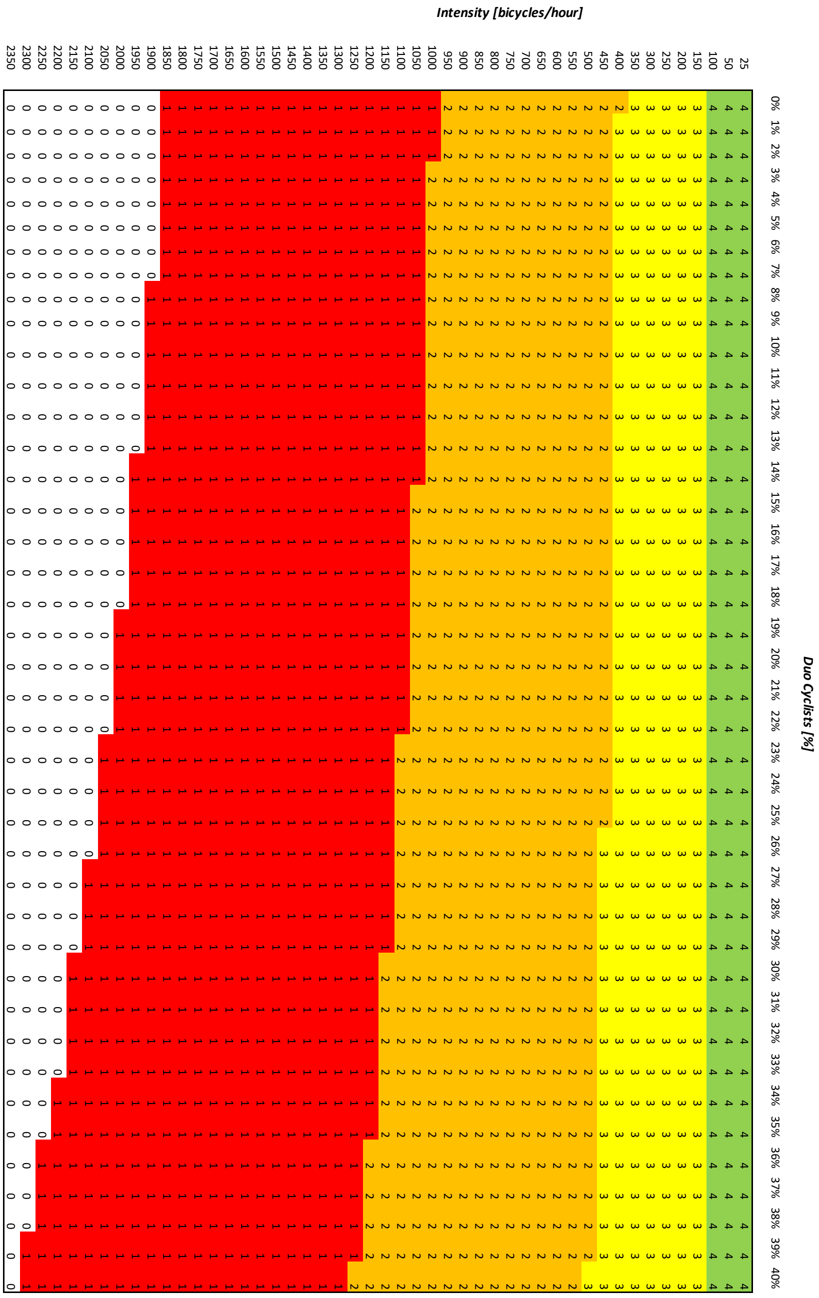
Bicycles in direction 1 [%]

Intensity [bicycles/hour]

	50%	53%	56%	59%	62%	65%	68%	71%	74%	77%	80%	83%	86%	89%	92%	95%	98%	100%
25	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4
50	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4
100	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4
150	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
200	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3
250	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3
300	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3
350	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	3
400	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	3
450	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2
500	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2
550	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2
600	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2
650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2
800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
1050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix E

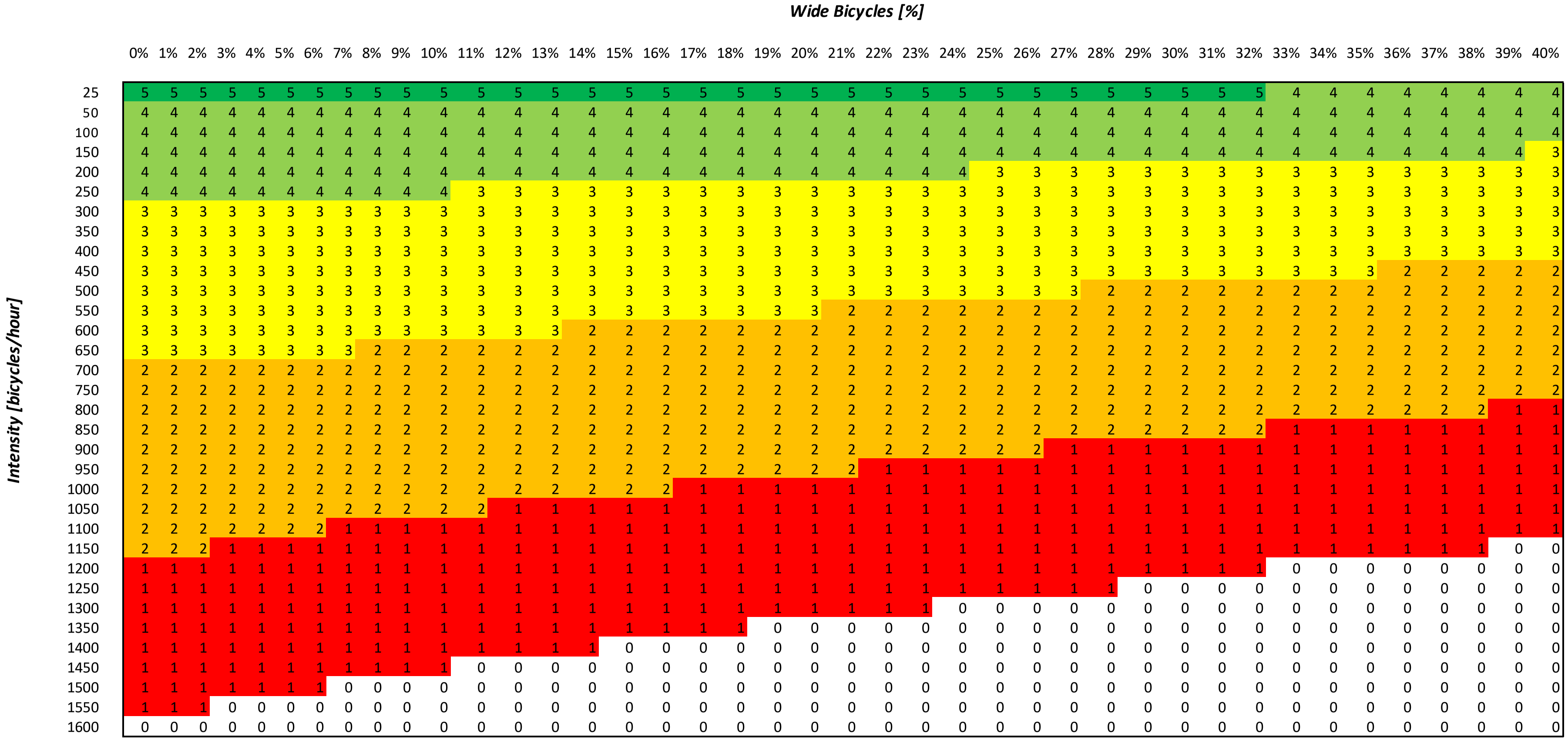
Matrices: Coupure Links - Sample on Current Design



Intensity [bicycles/hour]

Duo Cyclists [%]

	2350	2300	2250	2200	2150	2100	2050	2000	1950	1900	1850	1800	1750	1700	1650	1600	1550	1500	1450	1400	1350	1300	1250	1200	1150	1100	1050	1000	950	900	850	800	750	700	650	600	550	500	450	400	350	300	250	200	150	100	50	25
0%	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4	4
1%	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
2%	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
3%	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
4%	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
5%	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
6%	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
7%	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
8%	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
9%	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
10%	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
11%	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
12%	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
13%	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
14%	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
15%	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
16%	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
17%	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
18%	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
19%	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
20%	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
21%	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
22%	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
23%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
24%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
25%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
26%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
27%	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
28%	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
29%	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
30%	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
31%	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
32%	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
33%	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
34%	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
35%	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
36%	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
37%	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
38%	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
39%	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
40%	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4



Wide Bicycles [%]

Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4
50	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
100	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
150	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3
200	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
250	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
300	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
350	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
400	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
450	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2
500	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2
550	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
600	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
650	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
700	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
750	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
800	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1
850	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1
900	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
950	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1000	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1050	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1100	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1150	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
1200	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
1250	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
1300	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1350	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1400	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1450	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1500	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1550	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Mopeds [%]

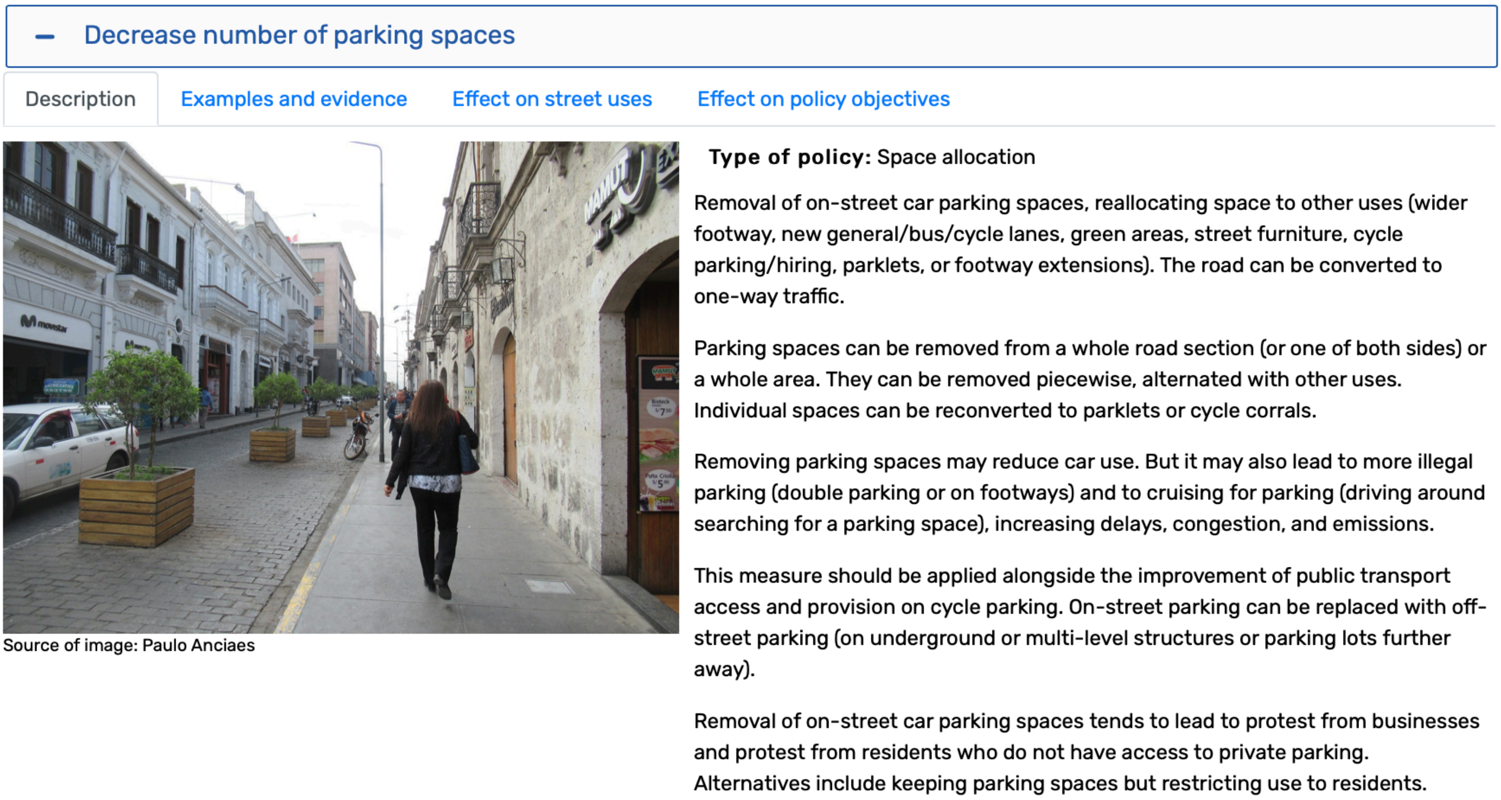
Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
50	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
100	5	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2
150	5	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
200	5	4	4	4	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
250	5	4	4	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
300	4	4	4	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
350	4	4	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
400	4	4	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
450	4	4	3	3	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
500	4	3	3	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
550	4	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
600	4	3	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
650	4	3	3	2	2	2	2	2	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
700	4	3	3	2	2	2	2	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
750	3	3	2	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
800	3	3	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
850	3	3	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
900	3	3	2	2	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
950	3	2	2	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1000	3	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1050	3	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1100	3	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1150	3	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1200	3	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1250	3	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1300	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1350	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1400	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1450	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1500	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1550	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1600	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1650	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1700	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1750	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1800	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1850	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1900	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1950	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2050	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2100	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2150	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2200	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2250	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2300	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2350	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bicycles in direction 1 [%]

Intensity [bicycles/hour]	50%	53%	56%	59%	62%	65%	68%	71%	74%	77%	80%	83%	86%	89%	92%	95%	98%	100%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
50	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5
100	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5
150	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5
200	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
250	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
300	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4
350	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4
400	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4
450	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4
500	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4
550	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4
600	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4
650	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4
700	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4
750	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4
800	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4
850	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4
900	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4
950	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4
1000	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4
1050	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4
1100	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	4
1150	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	4
1200	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	4
1250	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	4
1300	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	4
1350	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3
1400	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3
1450	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3
1500	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3
1550	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	3	3	3
1600	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3	3	3
1650	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2	3	3
1700	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
1750	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
1800	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	3	3
1850	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	3	3
1900	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3
1950	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3
2000	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3
2050	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3
2100	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3
2150	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3
2200	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3
2250	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	3	3
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	3
2350	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	3
2400	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	3
2450	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
2500	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
2550	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
2600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3
2650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3
2700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3
2750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3
2800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3
2850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
2900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
2950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
3000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
3050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3
4000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3

Appendix F

MORE Streetspace Intervention Tool - Example of Results



Source of image: Paulo Anciaes

Type of policy: Space allocation

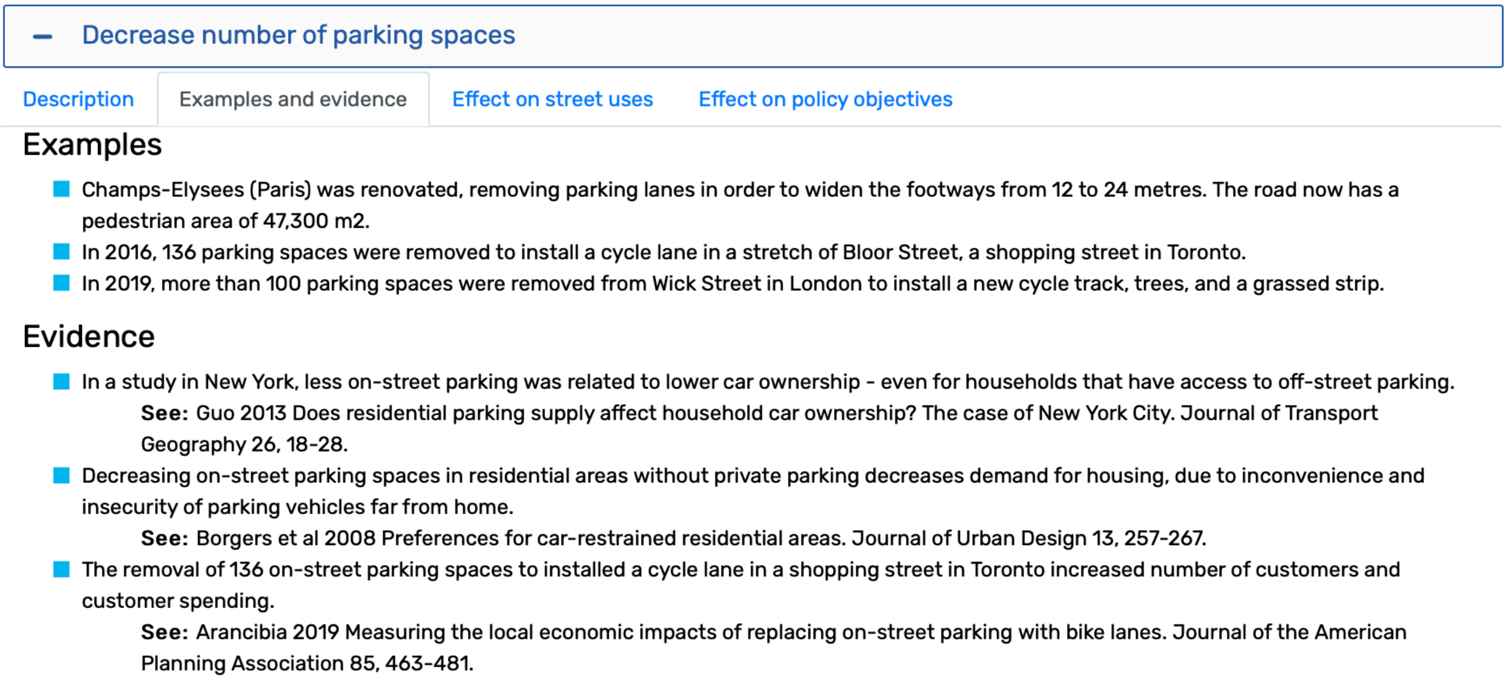
Removal of on-street car parking spaces, reallocating space to other uses (wider footway, new general/bus/cycle lanes, green areas, street furniture, cycle parking/hiring, parklets, or footway extensions). The road can be converted to one-way traffic.

Parking spaces can be removed from a whole road section (or one of both sides) or a whole area. They can be removed piecewise, alternated with other uses. Individual spaces can be reconverted to parklets or cycle corrals.

Removing parking spaces may reduce car use. But it may also lead to more illegal parking (double parking or on footways) and to cruising for parking (driving around searching for a parking space), increasing delays, congestion, and emissions.

This measure should be applied alongside the improvement of public transport access and provision on cycle parking. On-street parking can be replaced with off-street parking (on underground or multi-level structures or parking lots further away).

Removal of on-street car parking spaces tends to lead to protest from businesses and protest from residents who do not have access to private parking. Alternatives include keeping parking spaces but restricting use to residents.



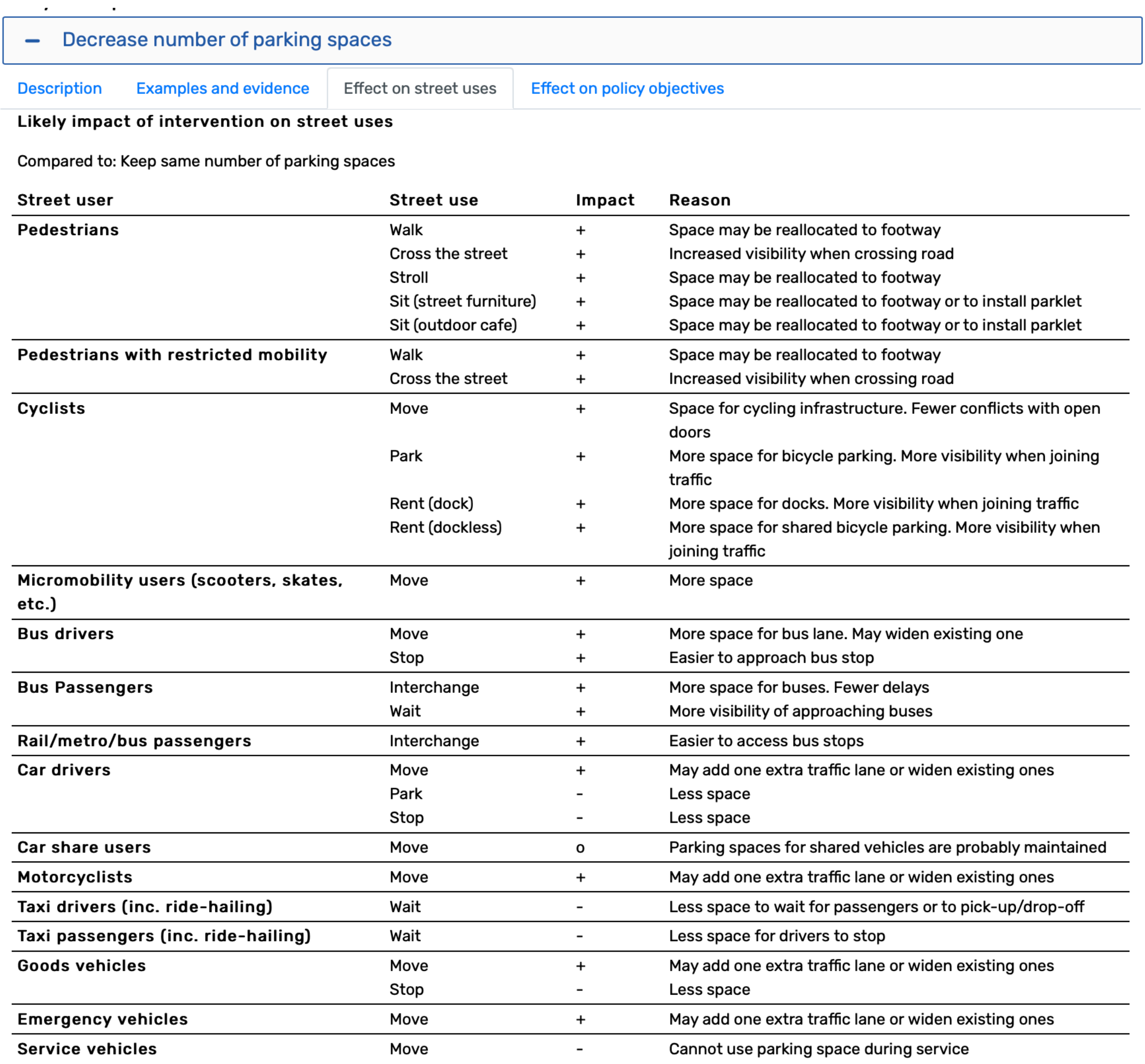
Decrease number of parking spaces

Examples

- Champs-Elysees (Paris) was renovated, removing parking lanes in order to widen the footways from 12 to 24 metres. The road now has a pedestrian area of 47,300 m2.
- In 2016, 136 parking spaces were removed to install a cycle lane in a stretch of Bloor Street, a shopping street in Toronto.
- In 2019, more than 100 parking spaces were removed from Wick Street in London to install a new cycle track, trees, and a grassed strip.

Evidence

- In a study in New York, less on-street parking was related to lower car ownership - even for households that have access to off-street parking.
  See: Guo 2013 Does residential parking supply affect household car ownership? The case of New York City. Journal of Transport Geography 26, 18-28.
- Decreasing on-street parking spaces in residential areas without private parking decreases demand for housing, due to inconvenience and insecurity of parking vehicles far from home.
  See: Borgers et al 2008 Preferences for car-restrained residential areas. Journal of Urban Design 13, 257-267.
- The removal of 136 on-street parking spaces to installed a cycle lane in a shopping street in Toronto increased number of customers and customer spending.
  See: Arancibia 2019 Measuring the local economic impacts of replacing on-street parking with bike lanes. Journal of the American Planning Association 85, 463-481.



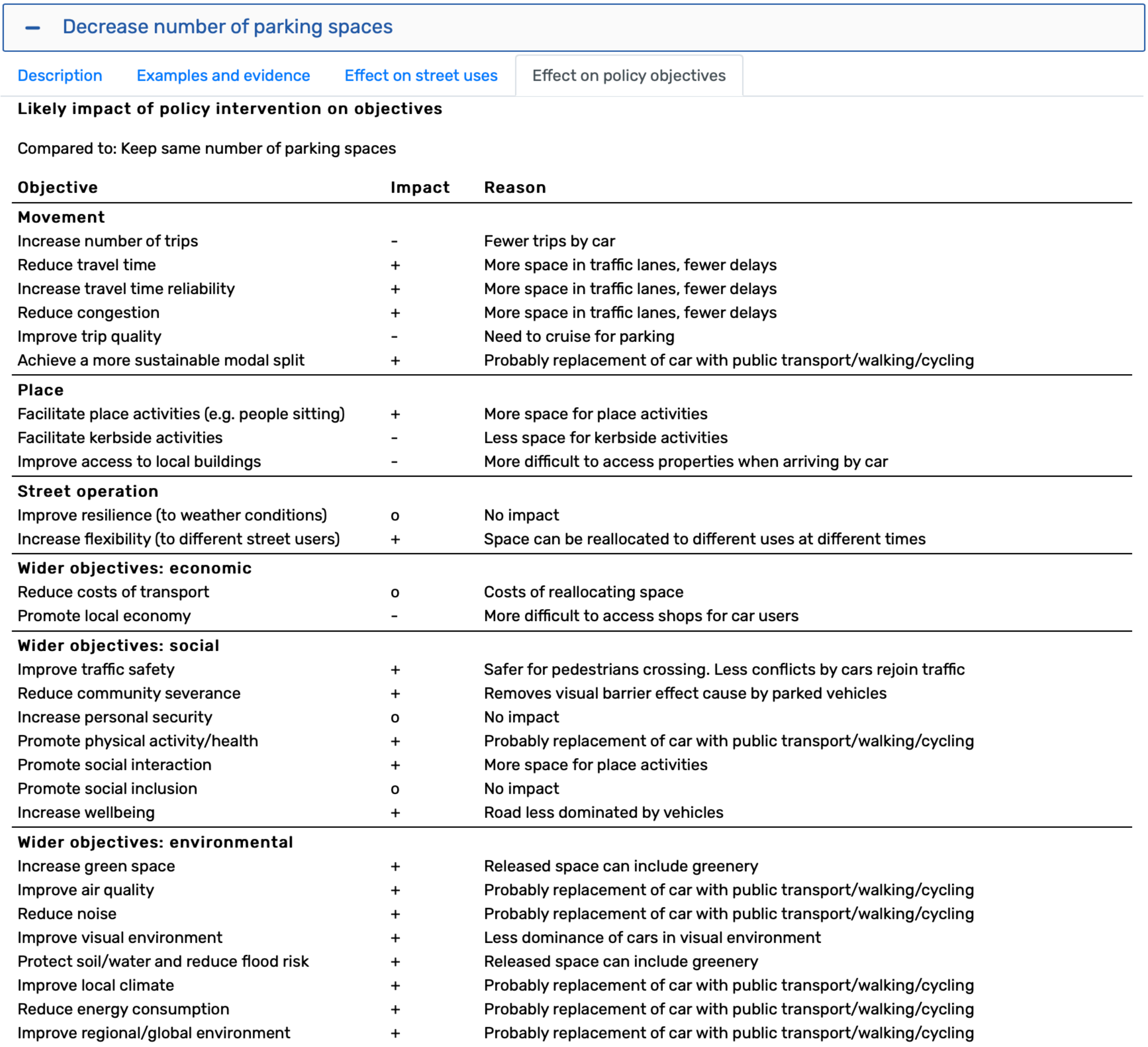
– Decrease number of parking spaces

Description | Examples and evidence | Effect on street uses | Effect on policy objectives

Likely impact of intervention on street uses

Compared to: Keep same number of parking spaces

Street user	Street use	Impact	Reason
Pedestrians	Walk	+	Space may be reallocated to footway
	Cross the street	+	Increased visibility when crossing road
	Stroll	+	Space may be reallocated to footway
	Sit (street furniture)	+	Space may be reallocated to footway or to install parklet
	Sit (outdoor cafe)	+	Space may be reallocated to footway or to install parklet
Pedestrians with restricted mobility	Walk	+	Space may be reallocated to footway
	Cross the street	+	Increased visibility when crossing road
Cyclists	Move	+	Space for cycling infrastructure. Fewer conflicts with open doors
	Park	+	More space for bicycle parking. More visibility when joining traffic
	Rent (dock)	+	More space for docks. More visibility when joining traffic
	Rent (dockless)	+	More space for shared bicycle parking. More visibility when joining traffic
Micromobility users (scooters, skates, etc.)	Move	+	More space
Bus drivers	Move	+	More space for bus lane. May widen existing one
	Stop	+	Easier to approach bus stop
Bus Passengers	Interchange	+	More space for buses. Fewer delays
	Wait	+	More visibility of approaching buses
Rail/metro/bus passengers	Interchange	+	Easier to access bus stops
Car drivers	Move	+	May add one extra traffic lane or widen existing ones
	Park	-	Less space
	Stop	-	Less space
Car share users	Move	o	Parking spaces for shared vehicles are probably maintained
Motorcyclists	Move	+	May add one extra traffic lane or widen existing ones
Taxi drivers (inc. ride-hailing)	Wait	-	Less space to wait for passengers or to pick-up/drop-off
Taxi passengers (inc. ride-hailing)	Wait	-	Less space for drivers to stop
Goods vehicles	Move	+	May add one extra traffic lane or widen existing ones
	Stop	-	Less space
Emergency vehicles	Move	+	May add one extra traffic lane or widen existing ones
Service vehicles	Move	-	Cannot use parking space during service



Decrease number of parking spaces

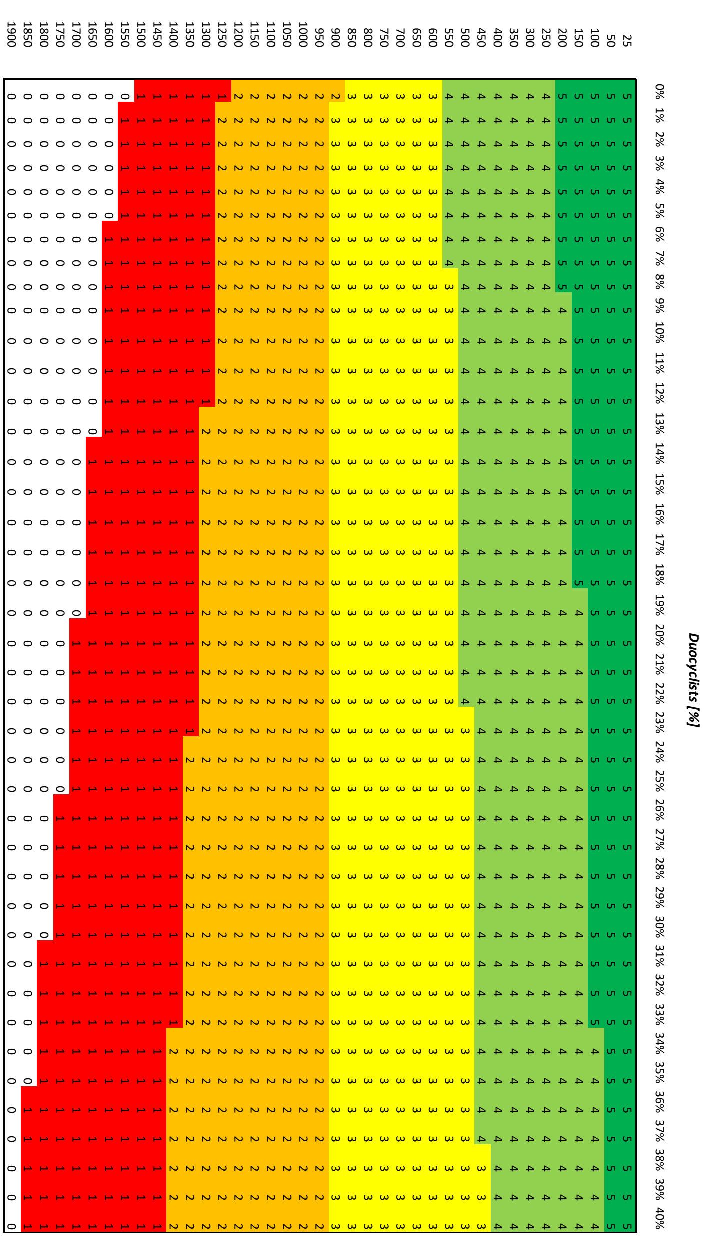
Likely impact of policy intervention on objectives

Compared to: Keep same number of parking spaces

Objective	Impact	Reason
Movement		
Increase number of trips	-	Fewer trips by car
Reduce travel time	+	More space in traffic lanes, fewer delays
Increase travel time reliability	+	More space in traffic lanes, fewer delays
Reduce congestion	+	More space in traffic lanes, fewer delays
Improve trip quality	-	Need to cruise for parking
Achieve a more sustainable modal split	+	Probably replacement of car with public transport/walking/cycling
Place		
Facilitate place activities (e.g. people sitting)	+	More space for place activities
Facilitate kerbside activities	-	Less space for kerbside activities
Improve access to local buildings	-	More difficult to access properties when arriving by car
Street operation		
Improve resilience (to weather conditions)	o	No impact
Increase flexibility (to different street users)	+	Space can be reallocated to different uses at different times
Wider objectives: economic		
Reduce costs of transport	o	Costs of reallocating space
Promote local economy	-	More difficult to access shops for car users
Wider objectives: social		
Improve traffic safety	+	Safer for pedestrians crossing. Less conflicts by cars rejoin traffic
Reduce community severance	+	Removes visual barrier effect cause by parked vehicles
Increase personal security	o	No impact
Promote physical activity/health	+	Probably replacement of car with public transport/walking/cycling
Promote social interaction	+	More space for place activities
Promote social inclusion	o	No impact
Increase wellbeing	+	Road less dominated by vehicles
Wider objectives: environmental		
Increase green space	+	Released space can include greenery
Improve air quality	+	Probably replacement of car with public transport/walking/cycling
Reduce noise	+	Probably replacement of car with public transport/walking/cycling
Improve visual environment	+	Less dominance of cars in visual environment
Protect soil/water and reduce flood risk	+	Released space can include greenery
Improve local climate	+	Probably replacement of car with public transport/walking/cycling
Reduce energy consumption	+	Probably replacement of car with public transport/walking/cycling
Improve regional/global environment	+	Probably replacement of car with public transport/walking/cycling

Appendix G

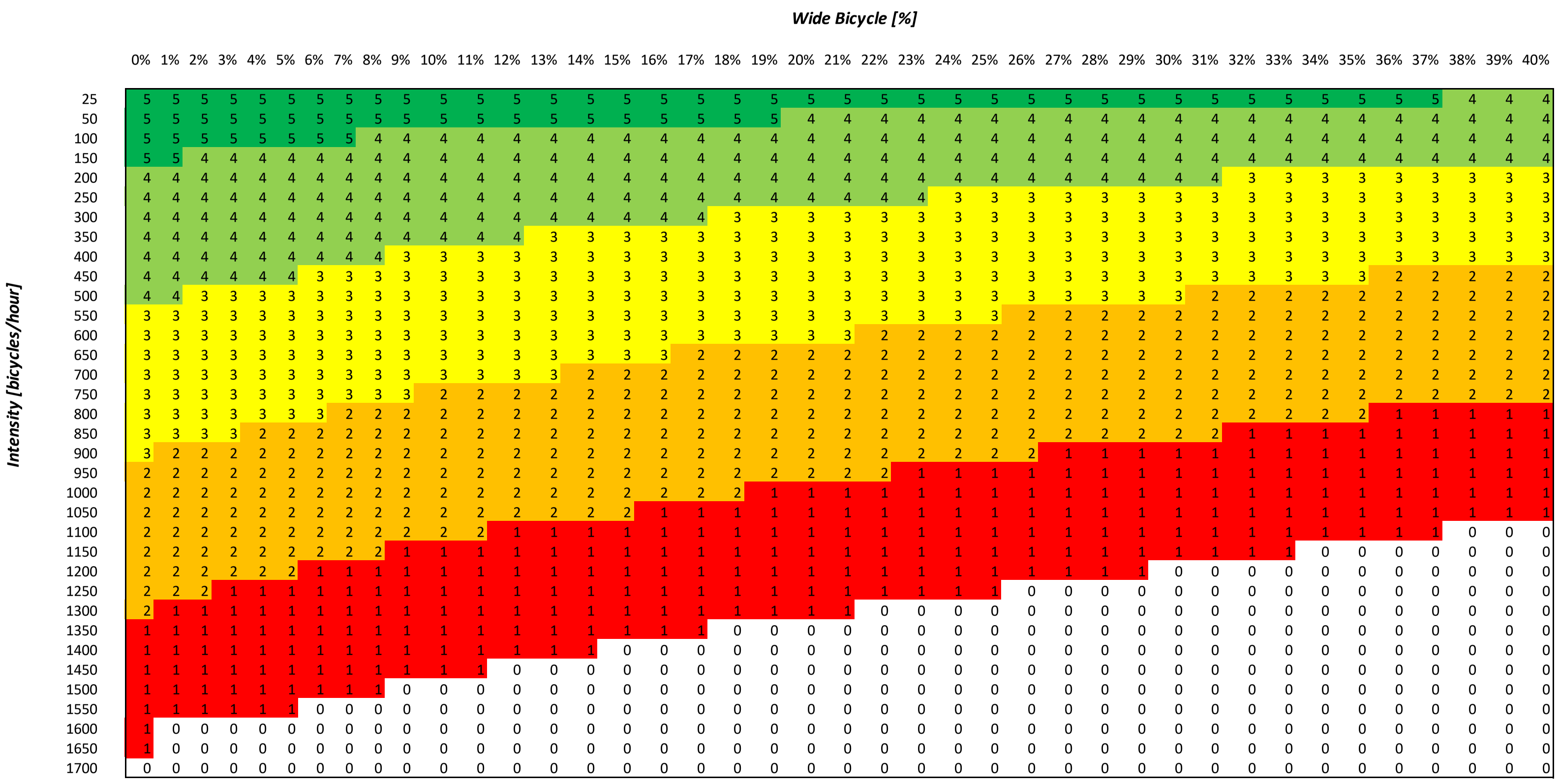
Matrices: Haarlemmerdijk - Current Design - 4% Mopeds



Intensity [bicycles/hour]

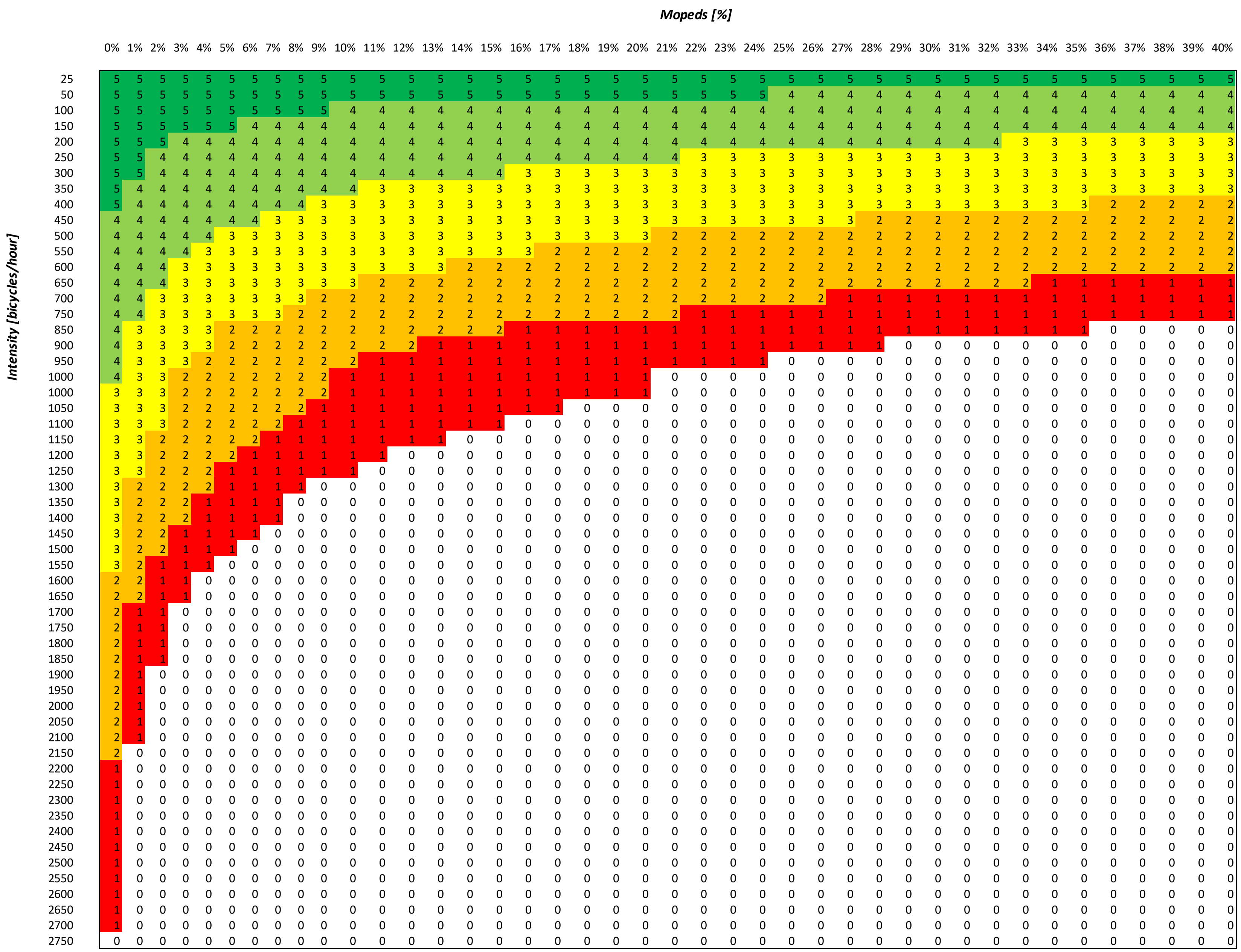
1900	1850	1800	1750	1700	1650	1600	1550	1500	1450	1400	1350	1300	1250	1200	1150	1100	1050	1000	950	900	850	800	750	700	650	600	550	500	450	400	350	300	250	200	150	100	50	25	
0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	5	0%
0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	5	1%
0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	5	2%
0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	5	3%
0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	5	4%
0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	5	5%
0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	5	6%
0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	5	7%
0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5	8%
0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	9%
0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	10%
0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	11%
0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	12%
0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	13%
0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	14%
0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	15%
0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	16%
0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	17%
0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	18%
0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	5	5	5	19%
0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	5	5	5	20%
0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	5	5	5	21%
0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	5	5	5	22%
0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	23%
0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	24%
0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	25%
0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	26%
0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	27%
0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	28%
0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	29%
0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	30%
0	0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	31%
0	0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	32%
0	0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	33%
0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	5	5	34%
0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	5	5	35%
0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	5	5	36%
0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	5	5	37%
0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	38%
0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	39%
0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	40%

Duocyclists [%]



Wide Bicycle [%]

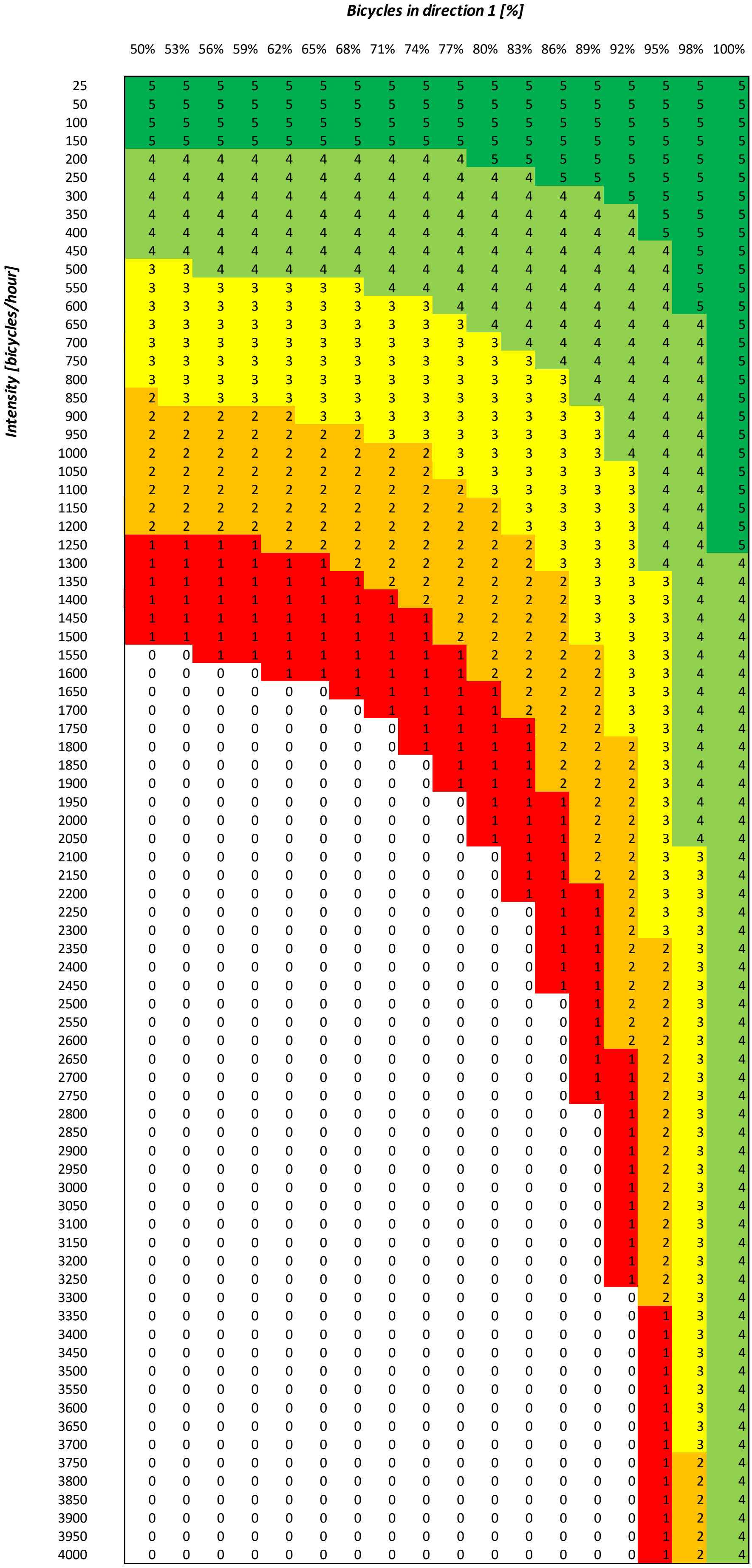
Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4
50	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
100	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
150	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
200	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3
250	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
300	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
350	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
400	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
450	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2
500	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2
550	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
600	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
650	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
700	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
750	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
800	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1
850	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1
900	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
950	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1000	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1050	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1100	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
1150	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
1200	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
1250	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1300	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1350	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1400	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1450	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1500	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1550	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1600	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1650	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Mopeds [%]

Intensity [bicycles/hour]

	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
50	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
100	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
150	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
200	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3
250	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
300	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
350	5	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
400	5	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2
450	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2
500	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
550	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
600	4	4	4	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
650	4	4	4	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
700	4	4	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
750	4	4	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
850	4	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
900	4	3	3	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
950	4	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1000	4	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1000	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1050	3	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1100	3	3	3	2	2	2	2	2	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1150	3	3	2	2	2	2	2	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1200	3	3	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1250	3	3	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1300	3	2	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1350	3	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1400	3	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1450	3	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1500	3	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1550	3	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1600	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1650	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1700	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1750	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1800	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1850	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1900	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1950	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2050	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2100	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2150	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2200	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2250	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2300	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2350	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2400	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2450	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2500	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2550	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2600	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2650	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2700	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

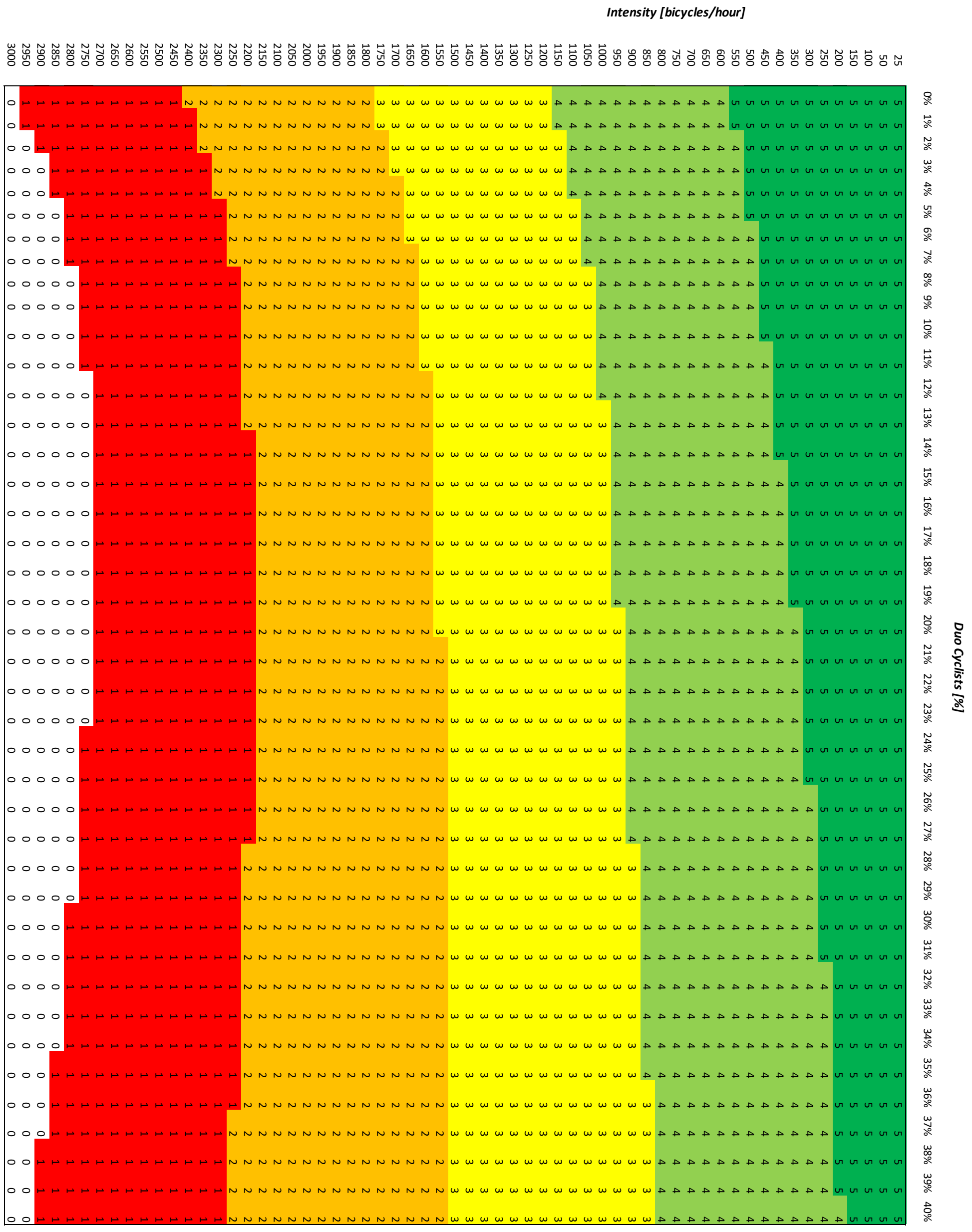


Bicycles in direction 1 [%]

Intensity [bicycles/hour]	50%	53%	56%	59%	62%	65%	68%	71%	74%	77%	80%	83%	86%	89%	92%	95%	98%	100%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
50	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
100	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
150	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
200	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5
250	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5
300	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5
350	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5
400	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5
450	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5
500	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5
550	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	5	5
600	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5
650	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5
700	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	5
750	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	5
800	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	5
850	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	5
900	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	5
950	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	5
1000	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4	4	5
1050	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	5
1100	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4	5
1150	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4	5
1200	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4	5
1250	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	4	4	5
1300	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	4	4	4
1350	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	4	4
1400	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	4	4
1450	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3	4	4
1500	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3	4	4
1550	0	0	1	1	1	1	1	1	1	1	2	2	2	2	3	3	4	4
1600	0	0	0	0	1	1	1	1	1	1	2	2	2	2	3	3	4	4
1650	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3	3	4	4
1700	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3	4	4
1750	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	3	4	4
1800	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	4	4
1850	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	3	4	4
1900	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	3	4	4
1950	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4	4
2000	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4	4
2050	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4	4
2100	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3	4
2150	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3	4
2200	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	3	3	4
2250	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	3	4
2300	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	3	4
2350	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4
2400	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4
2450	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4
2500	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	4
2550	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	4
2600	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	4
2650	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4
2700	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4
2750	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4
2800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
2850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
2900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
2950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	4
3350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	4
3400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	4
3450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	4
3500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	4
3550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	4
3600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	4
3650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	4
3700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	4
3750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4
3800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4
3850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4
3900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4
3950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4
4000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4

Appendix H

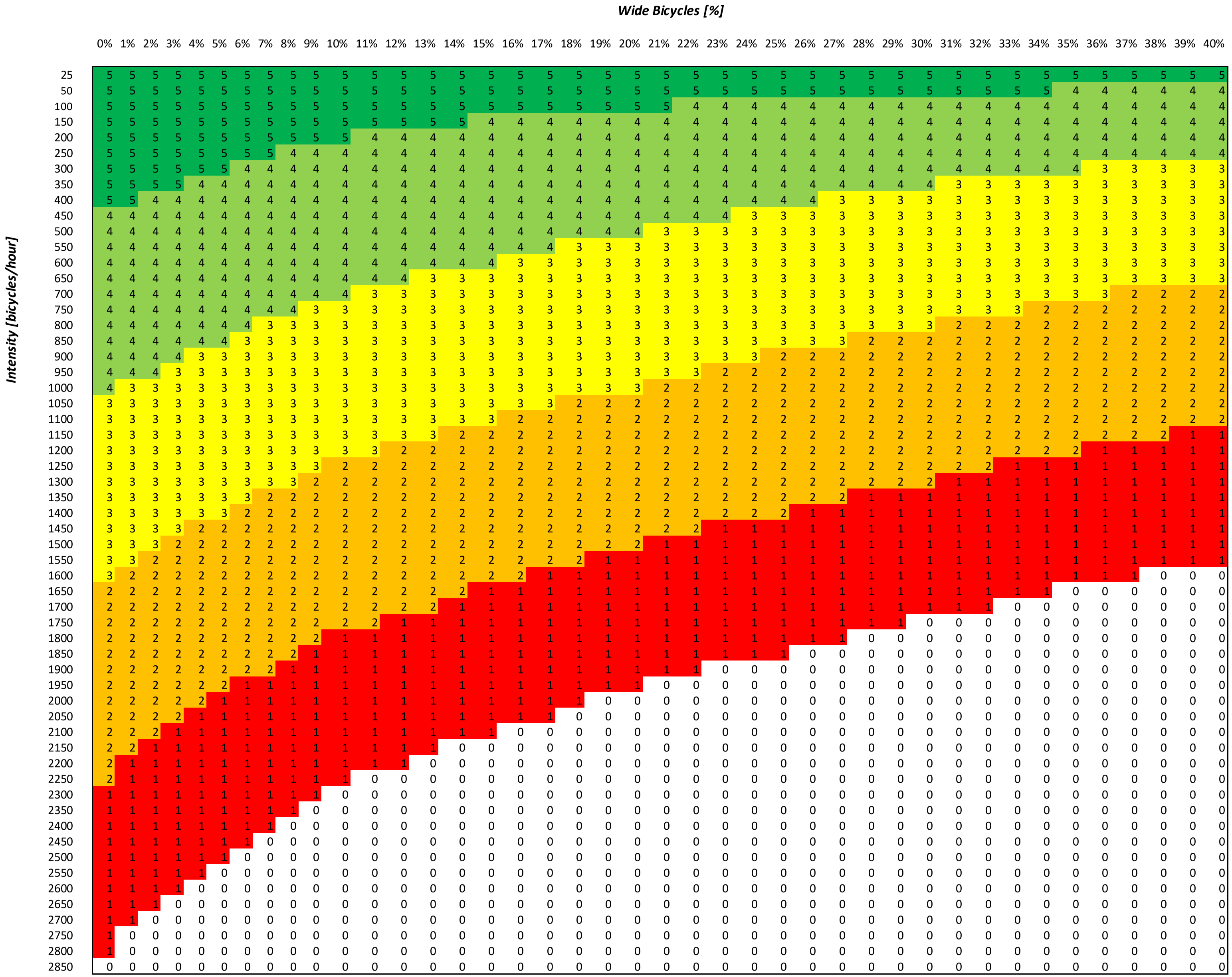
Matrices: Haarlemmerdijk - Current Design - 0% Mopeds



Intensity [bicycles/hour]

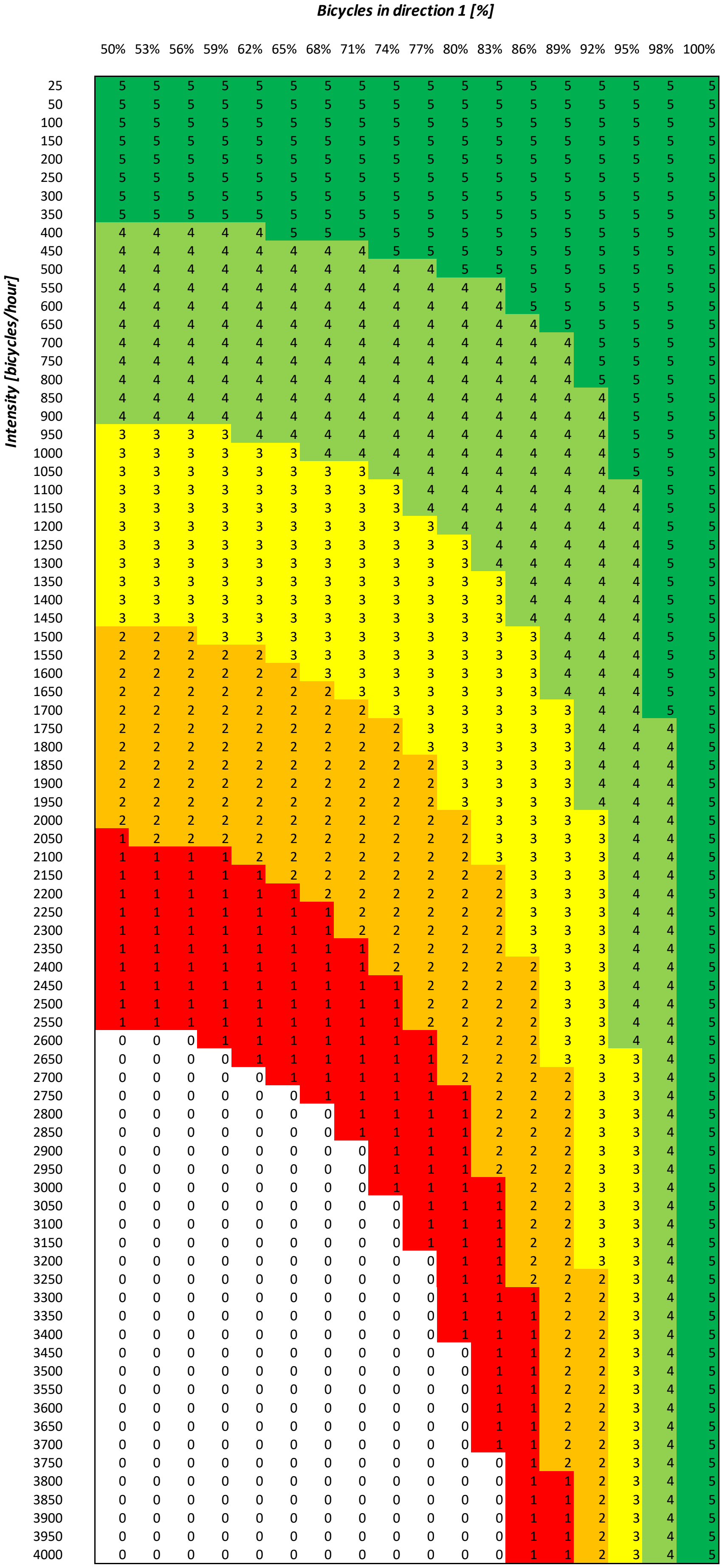
Duo Cyclists [%]

	3000	2950	2900	2850	2800	2750	2700	2650	2600	2550	2500	2450	2400	2350	2300	2250	2200	2150	2100	2050	2000	1950	1900	1850	1800	1750	1700	1650	1600	1550	1500	1450	1400	1350	1300	1250	1200	1150	1100	1050	1000	950	900	850	800	750	700	650	600	550	500	450	400	350	300	250	200	150	100	50	25
0%	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5
1%	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5
2%	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5
3%	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5
4%	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5
5%	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5
6%	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5
7%	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5
8%	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5
9%	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5
10%	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5
11%	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5
12%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5
13%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5
14%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5
15%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5
16%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5
17%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5
18%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5
19%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5
20%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5
21%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5
22%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5
23%	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5
24%	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5
25%	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5
26%	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5
27%	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5
28%	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5
29%	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5
30%	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5
31%	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5
32%	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5
33%	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5
34%	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5
35%	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5
36%	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5
37%	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5
38%	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5
39%	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5
40%	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5



Wide Bicycles [%]

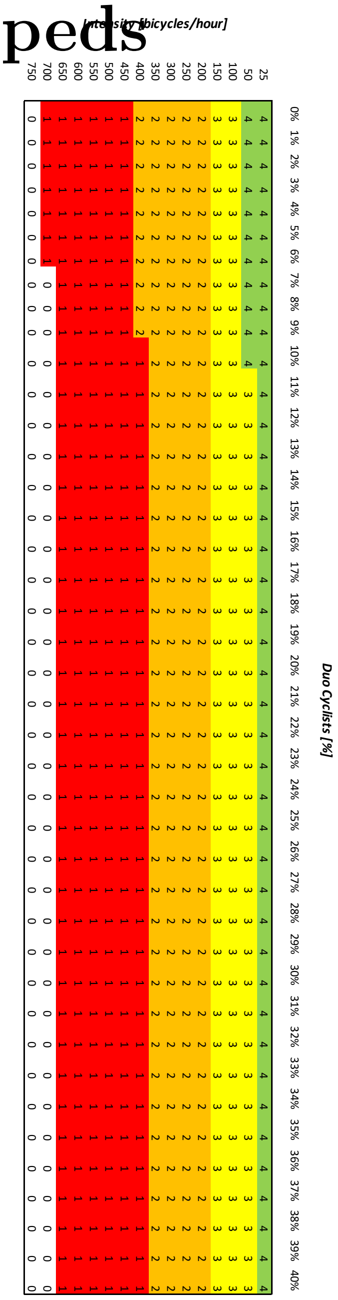
Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
50	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4
100	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
150	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
200	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
250	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
300	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3
350	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3
400	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
450	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
500	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
550	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
600	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
650	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
700	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2
750	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2
800	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2
850	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2
900	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
950	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1000	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1050	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1100	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1150	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1
1200	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1
1250	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1
1300	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1
1350	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
1400	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1450	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1500	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1550	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1600	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
1650	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
1700	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
1750	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
1800	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1850	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1900	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1950	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2050	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2100	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2150	2	2	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2200	2	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2250	2	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2300	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2350	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2400	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2450	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2500	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2550	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2600	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2650	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2700	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2750	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2800	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



	Bicycles in direction 1 [%]																	
Intensity [bicycles/hour]	50%	53%	56%	59%	62%	65%	68%	71%	74%	77%	80%	83%	86%	89%	92%	95%	98%	100%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
50	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
100	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
150	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
200	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
250	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
300	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
350	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
400	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5
450	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5
500	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5
550	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5
600	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5
650	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5
700	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5
750	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5
800	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5
850	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5
900	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5
950	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	5	5	5
1000	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	5	5	5
1050	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5
1100	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5
1150	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5
1200	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	5	5
1250	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	5	5
1300	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	5	5
1350	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	5	5
1400	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	5	5
1450	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	5	5
1500	2	2	2	3	3	3	3	3	3	3	3	3	3	4	4	4	5	5
1550	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	5	5
1600	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	5	5
1650	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	5	5
1700	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	5	5
1750	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4	4	5
1800	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4	4	5
1850	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4	4	5
1900	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4	4	5
1950	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4	4	5
2000	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4	5
2050	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4	5
2100	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	4	4	5
2150	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	4	4	5
2200	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	4	4	5
2250	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	4	4	5
2300	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	4	4	5
2350	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3	4	4	5
2400	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	4	4	5
2450	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	4	4	5
2500	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	4	4	5
2550	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	4	4	5
2600	0	0	0	1	1	1	1	1	1	1	2	2	2	3	3	4	4	5
2650	0	0	0	0	1	1	1	1	1	1	2	2	2	3	3	3	4	5
2700	0	0	0	0	0	1	1	1	1	1	2	2	2	2	3	3	4	5
2750	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3	3	4	5
2800	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3	4	5
2850	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3	4	5
2900	0	0	0	0	0	0	0	0	1	1	1	2	2	2	3	3	4	5
2950	0	0	0	0	0	0	0	0	1	1	1	2	2	2	3	3	4	5
3000	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	3	4	5
3050	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3	4	5
3100	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3	4	5
3150	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3	4	5
3200	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3	4	5
3250	0	0	0	0	0	0	0	0	0	0	1	1	2	2	2	3	4	5
3300	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4	5
3350	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4	5
3400	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4	5
3450	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4	5
3500	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4	5
3550	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4	5
3600	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4	5
3650	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4	5
3700	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4	5
3750	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	4	5
3800	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4	5
3850	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4	5
3900	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4	5
3950	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4	5
4000	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4	5

Appendix I

Matrices: Haarlemmerdijk - Liveable Street Design - 4% of mopeds

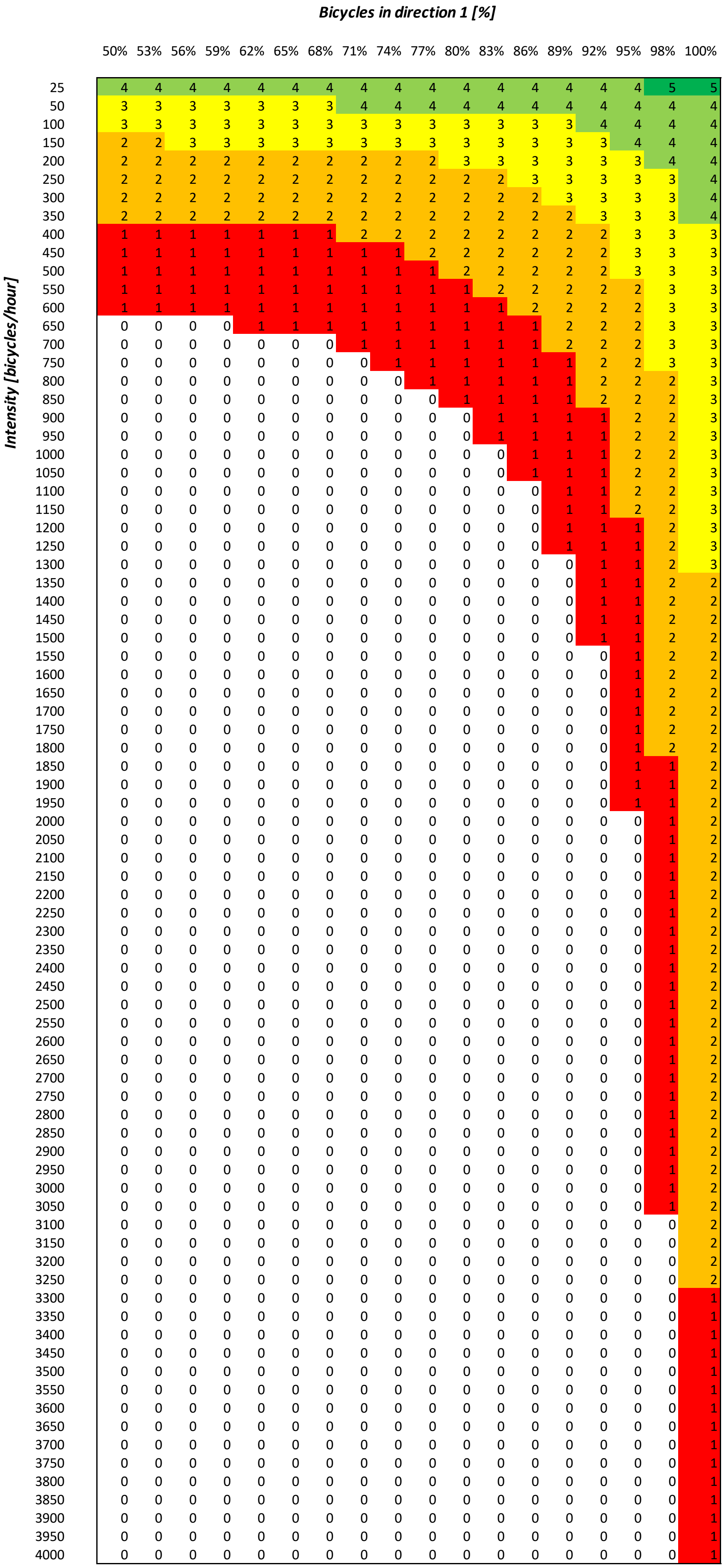


Duo Cyclists [%]

Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
50	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
100	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
150	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
200	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
250	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
300	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
350	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
400	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
450	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
550	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
600	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
650	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
700	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Wide Bicycles [%]

Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
50	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
100	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
150	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
200	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
250	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
300	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
350	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
400	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
450	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
500	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
550	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
600	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
650	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
700	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

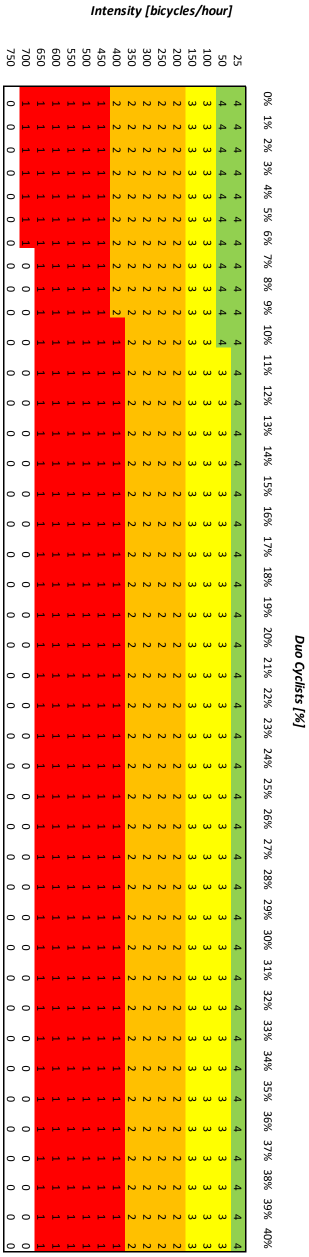


Bicycles in direction 1 [%]

Intensity [bicycles/hour]	50%	53%	56%	59%	62%	65%	68%	71%	74%	77%	80%	83%	86%	89%	92%	95%	98%	100%
25	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5
50	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4
100	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4
150	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4
200	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4
250	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4
300	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4
350	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	4
400	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3
450	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3
500	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3
550	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3
600	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3
650	0	0	0	0	1	1	1	1	1	1	1	1	1	2	2	2	3	3
700	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	3	3
750	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	3	3
800	0	0	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3
850	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3
900	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3
950	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3
1000	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3
1050	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3
1100	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
1150	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
1200	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	3
1250	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	3
1300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
1350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
1450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
1500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
1550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
1900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
4000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

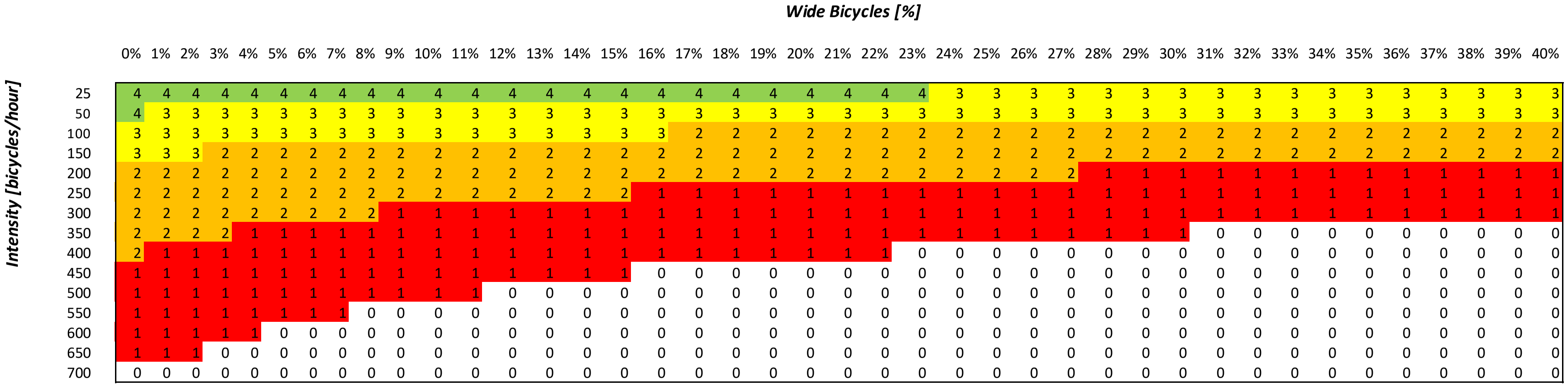
Appendix J

Matrices: Haarlemmerdijk - Liveable Street Design - 0% of mopeds



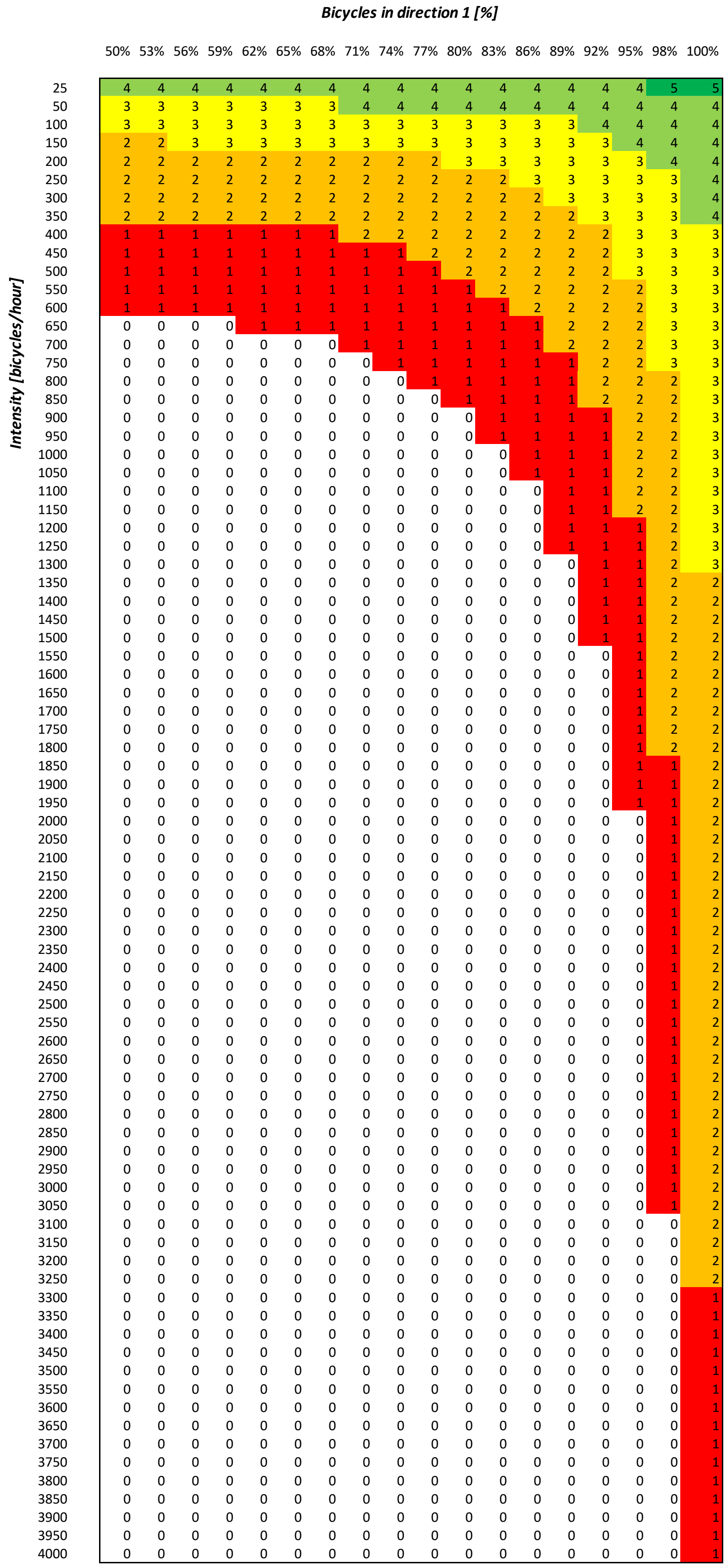
Intensity [bicycles/hour]

Duo Cyclists [%]	750	700	650	600	550	500	450	400	350	300	250	200	150	100	50	25
0%	0	1	1	1	1	1	1	2	2	2	2	2	3	3	4	4
1%	0	1	1	1	1	1	1	2	2	2	2	2	3	3	4	4
2%	0	1	1	1	1	1	1	2	2	2	2	2	3	3	4	4
3%	0	1	1	1	1	1	1	2	2	2	2	2	3	3	4	4
4%	0	1	1	1	1	1	1	2	2	2	2	2	3	3	4	4
5%	0	1	1	1	1	1	1	2	2	2	2	2	3	3	4	4
6%	0	1	1	1	1	1	1	2	2	2	2	2	3	3	4	4
7%	0	0	1	1	1	1	1	2	2	2	2	2	3	3	4	4
8%	0	0	1	1	1	1	1	2	2	2	2	2	3	3	4	4
9%	0	0	1	1	1	1	1	2	2	2	2	2	3	3	4	4
10%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	4	4
11%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
12%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
13%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
14%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
15%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
16%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
17%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
18%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
19%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
20%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
21%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
22%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
23%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
24%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
25%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
26%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
27%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
28%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
29%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
30%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
31%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
32%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
33%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
34%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
35%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
36%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
37%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
38%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
39%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4
40%	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	4



Wide Bicycles [%]

Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
50	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
100	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
150	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
200	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
250	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
300	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
350	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
400	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
450	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
500	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
550	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
600	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
650	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

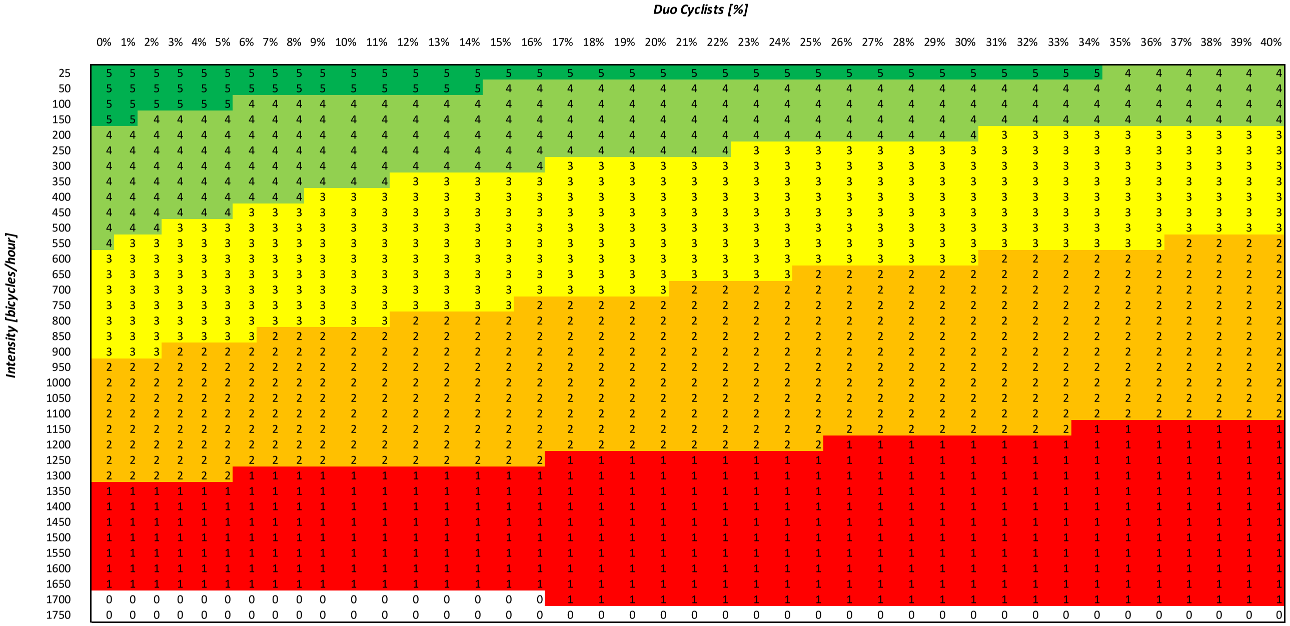


Bicycles in direction 1 [%]

Intensity [bicycles/hour]	50%	53%	56%	59%	62%	65%	68%	71%	74%	77%	80%	83%	86%	89%	92%	95%	98%	100%
25	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5
50	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4
100	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4
150	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4
200	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4
250	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4
300	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4
350	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	4
400	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3
450	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3
500	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3
550	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3
600	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3
650	0	0	0	0	1	1	1	1	1	1	1	1	1	2	2	2	3	3
700	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	3	3
750	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	3	3
800	0	0	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3
850	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3
900	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3
950	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3
1000	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3
1050	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3
1100	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
1150	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
1200	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	3
1250	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	3
1300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
1350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
1450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
1500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
1550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
1900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
4000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Appendix K

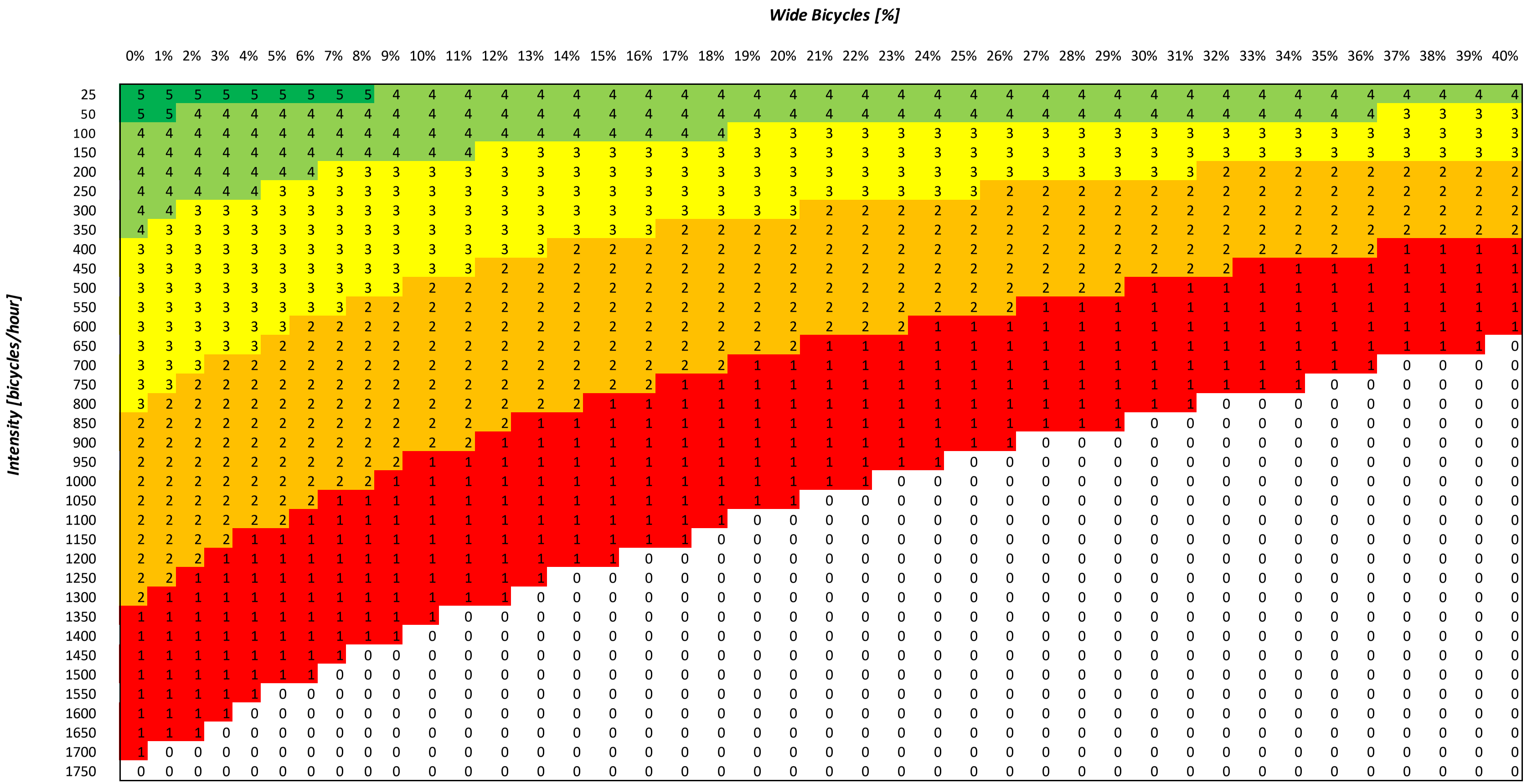
Matrices: Haarlemmerdijk - Obstacle 1



Duo Cyclists [%]

Intensity [bicycles/hour]

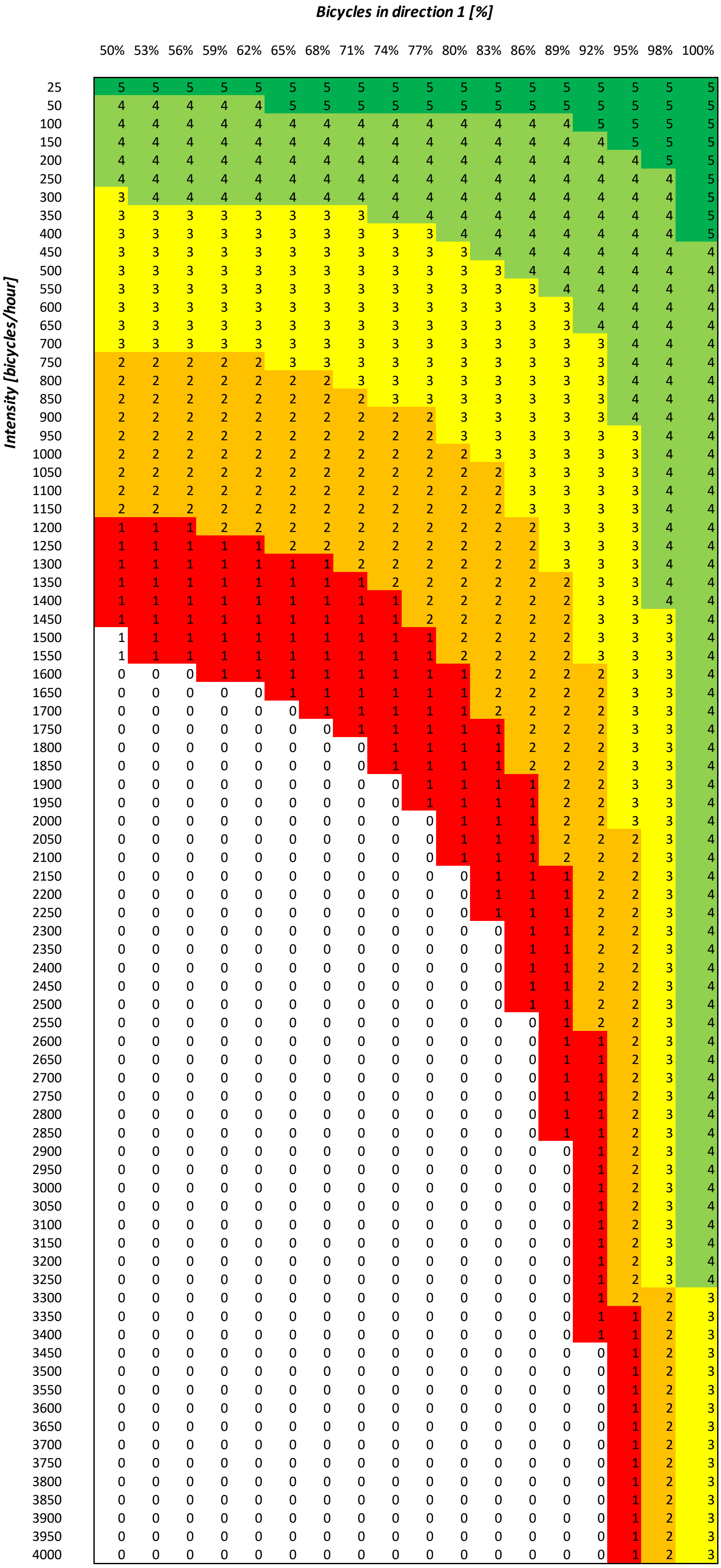
	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4
50	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
100	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
150	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
200	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3
250	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
300	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
350	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
400	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
450	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
500	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
550	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2
600	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2
650	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
700	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
750	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
800	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
850	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
900	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
950	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1000	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1050	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1100	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1150	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
1200	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1250	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1300	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1350	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1400	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1450	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1550	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1600	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1650	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Wide Bicycles [%]

Intensity [bicycles/hour]

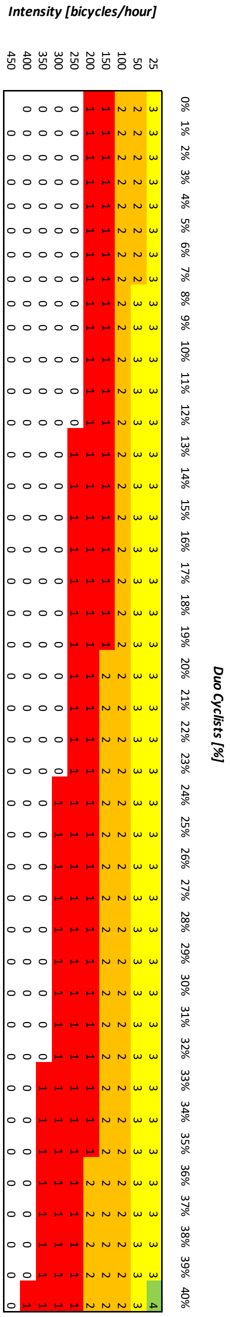
	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
50	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3
100	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
150	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
200	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2
250	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
300	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
350	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
400	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1
450	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1
500	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
550	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
600	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
650	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
700	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
750	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
800	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
850	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
900	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
950	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1000	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1050	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1100	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1150	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1200	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1250	2	2	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1300	2	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1350	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1400	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1450	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1500	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1550	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1600	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1650	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1700	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Intensity [bicycles/hour]	Bicycles in direction 1 [%]																	
	50%	53%	56%	59%	62%	65%	68%	71%	74%	77%	80%	83%	86%	89%	92%	95%	98%	100%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
50	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5
100	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5
150	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5
200	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5
250	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5
300	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5
350	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	5
400	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5
450	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4
500	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4
550	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4
600	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4
650	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4
700	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4
750	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	4	4	4
800	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4
850	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
900	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4	4
950	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4
1000	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4
1050	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4
1100	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4
1150	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4
1200	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	4	4
1250	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	4	4
1300	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	4	4
1350	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	4	4
1400	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	4	4
1450	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	4
1500	1	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3	4
1550	1	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3	4
1600	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	3	3	4
1650	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	3	3	4
1700	0	0	0	0	0	0	1	1	1	1	1	2	2	2	2	3	3	4
1750	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3	3	4
1800	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3	4
1850	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3	4
1900	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	3	4
1950	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	3	4
2000	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3	4
2050	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	3	4
2100	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	3	4
2150	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4
2200	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4
2250	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4
2300	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4
2350	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4
2400	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4
2450	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4
2500	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4
2550	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	4
2600	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4
2650	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4
2700	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4
2750	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4
2800	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4
2850	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4
2900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
2950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3
3350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
3400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
3450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
4000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3

Appendix L

Matrices: Haarlemmerdijk - Obstacle 2



	Intensity [bicycles/hour]									
Duo Cyclists [%]	450	400	350	300	250	200	150	100	50	25
0%		0	0	0	0	1	1	2	2	3
1%	0	0	0	0	0	1	1	2	2	3
2%	0	0	0	0	0	1	1	2	2	3
3%	0	0	0	0	0	1	1	2	2	3
4%	0	0	0	0	0	1	1	2	2	3
5%	0	0	0	0	0	1	1	2	2	3
6%	0	0	0	0	0	1	1	2	2	3
7%	0	0	0	0	0	1	1	2	2	3
8%	0	0	0	0	0	1	1	2	3	3
9%	0	0	0	0	0	1	1	2	3	3
10%	0	0	0	0	0	1	1	2	3	3
11%	0	0	0	0	0	1	1	2	3	3
12%	0	0	0	0	0	1	1	2	3	3
13%	0	0	0	0	1	1	1	2	3	3
14%	0	0	0	0	1	1	1	2	3	3
15%	0	0	0	0	1	1	1	2	3	3
16%	0	0	0	0	1	1	1	2	3	3
17%	0	0	0	0	1	1	1	2	3	3
18%	0	0	0	0	1	1	1	2	3	3
19%	0	0	0	0	1	1	1	2	3	3
20%	0	0	0	0	1	1	2	2	3	3
21%	0	0	0	0	1	1	2	2	3	3
22%	0	0	0	0	1	1	2	2	3	3
23%	0	0	0	0	1	1	2	2	3	3
24%	0	0	0	1	1	1	2	2	3	3
25%	0	0	0	1	1	1	2	2	3	3
26%	0	0	0	1	1	1	2	2	3	3
27%	0	0	0	1	1	1	2	2	3	3
28%	0	0	0	1	1	1	2	2	3	3
29%	0	0	0	1	1	1	2	2	3	3
30%	0	0	0	1	1	1	2	2	3	3
31%	0	0	0	1	1	1	2	2	3	3
32%	0	0	0	1	1	1	2	2	3	3
33%	0	0	1	1	1	1	2	2	3	3
34%	0	0	1	1	1	1	2	2	3	3
35%	0	0	1	1	1	1	2	2	3	3
36%	0	0	1	1	1	2	2	2	3	3
37%	0	0	1	1	1	2	2	2	3	3
38%	0	0	1	1	1	2	2	2	3	3
39%	0	0	1	1	1	2	2	2	3	3
40%	0	1	1	1	1	2	2	2	3	4

Intensity [bicycles/hour]	Wide Bicycles [%]																																								
	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
50	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
100	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
150	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
200	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
250	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bicycles in direction 1 [%]

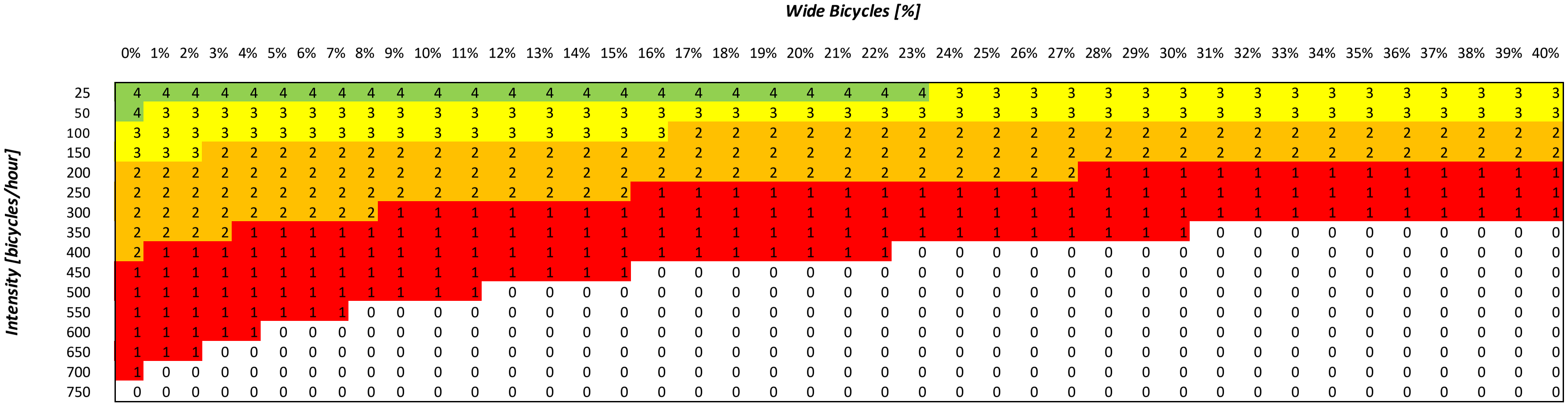
Intensity [bicycles/hour]

	50%	53%	56%	59%	62%	65%	68%	71%	74%	77%	80%	83%	86%	89%	92%	95%	98%	100%
25	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4
50	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4
100	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4
150	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3
200	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3
250	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	3	3
300	0	0	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3
350	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3
400	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3
450	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2
500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
1050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
1100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix M

Matrices: Haarlemmerdijk - Obstacle 3

Intensity [bicycles/hour]	Duo Cyclists [%]																																								
	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
50	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
100	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
150	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
200	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
250	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
300	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
350	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
400	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
450	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
550	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
600	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
650	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
700	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



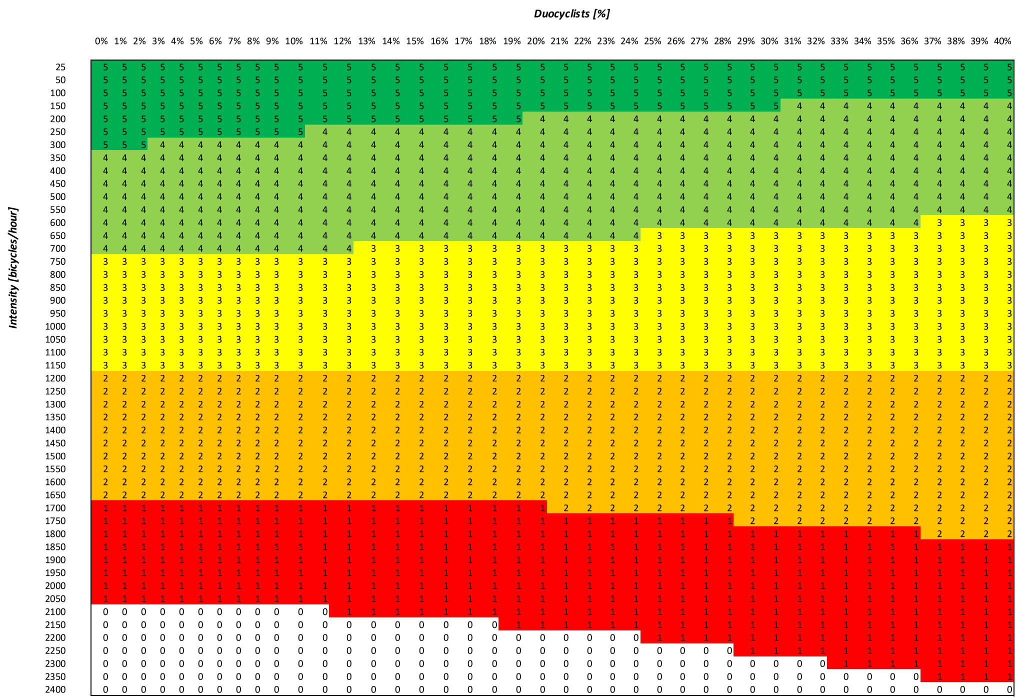
Wide Bicycles [%]

Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
50	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
100	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
150	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
200	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
250	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
300	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
350	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
400	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
450	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
500	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
550	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
600	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
650	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
700	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Bicycles in direction 1 [%]																	
Intensity [bicycles/hour]	50%	53%	56%	59%	62%	65%	68%	71%	74%	77%	80%	83%	86%	89%	92%	95%	98%	100%
25	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5
50	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4
100	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4
150	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4
200	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4
250	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4
300	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4
350	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	4
400	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3
450	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3
500	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3
550	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3
600	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3
650	0	0	0	0	1	1	1	1	1	1	1	1	1	2	2	2	3	3
700	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	3	3
750	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	3	3
800	0	0	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3
850	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3
900	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3
950	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3
1000	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3
1050	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3
1100	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
1150	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
1200	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	3
1250	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	3
1300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
1350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
1450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
1500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2
1550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
1900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
2950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
3100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
4000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Appendix N

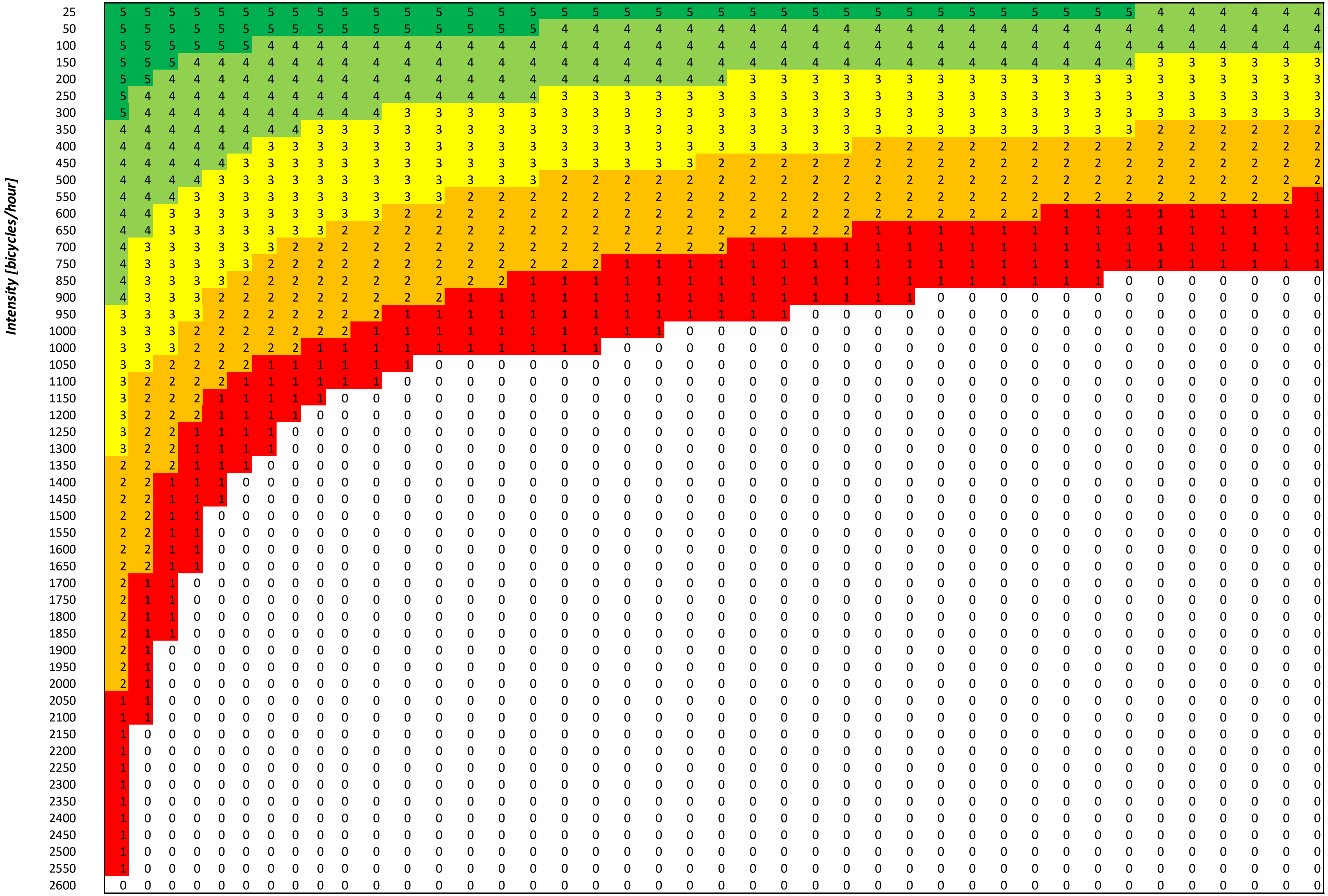
Matrices: Haarlemmerdijk - Sample on Current Design



	Duocyclists [%]																																							
Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
50	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
100	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
150	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4
200	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
250	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
300	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
350	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
400	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
450	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
500	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
550	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
600	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3
650	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
700	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
750	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
800	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
850	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
900	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
950	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1000	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1050	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1100	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1150	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1200	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1250	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1300	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1350	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1400	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1450	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1500	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1550	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1600	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1650	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1700	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1750	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
1800	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2
1850	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1900	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1950	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2050	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2100	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
2350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
2400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Wide Bicycle [%]

Intensity [bicycles/hour]	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
50	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4
100	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
150	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
200	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
250	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3
300	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3
350	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
400	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
450	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
500	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
550	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
600	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
650	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2
700	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
750	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2
800	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
850	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
900	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
950	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1000	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
1050	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1
1100	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1
1150	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
1200	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1250	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1300	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1350	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1400	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
1450	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
1500	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
1550	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
1600	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1650	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1700	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1750	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1800	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1850	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1900	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1950	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2050	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2100	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2150	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2200	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2250	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Intensity [bicycles/hour]	Mopeds [%]																																							
	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4
50	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
100	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
150	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3
200	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
250	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
300	5	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
350	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2
400	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
450	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
500	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
550	4	4	4	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
600	4	4	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1
650	4	4	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
700	4	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
750	4	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
850	4	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
900	4	3	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
950	3	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1000	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1000	3	3	3	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1050	3	3	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1100	3	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1150	3	2	2	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1200	3	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1250	3	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1300	3	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1350	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1400	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1450	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1500	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1550	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1600	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1650	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1700	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1750	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1800	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1850	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1900	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1950	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2050	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2100	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2150	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2200	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2250	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2300	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2350	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2400	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2450	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2500	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2550	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bicycles in direction 1 [%]

Intensity [bicycles/hour]	50%	53%	56%	59%	62%	65%	68%	71%	74%	77%	80%	83%	86%	89%	92%	95%	98%	100%
25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
50	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
100	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
150	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
200	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
250	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5
300	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5
350	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5
400	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5
450	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5
500	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5
550	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5
600	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5
650	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5
700	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	5	5
750	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	5	5
800	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5
850	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	5	5
900	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	5
950	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	5
1000	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	5
1050	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	5
1100	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	5
1150	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	5
1200	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	5
1250	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	5
1300	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4	4	5
1350	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4	4	5
1400	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4	5
1450	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4	5
1500	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4	5
1550	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4	5
1600	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	4	4	5
1650	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	4	4	5
1700	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	4	4	5
1750	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	4	4	5
1800	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	4	5
1850	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3	4	5
1900	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3	4	5
1950	1	1	1	1	1	1	1	1	1	1	2	2	2	3	3	3	4	5
2000	0	0	0	1	1	1	1	1	1	1	2	2	2	2	3	3	4	5
2050	0	0	0	0	1	1	1	1	1	1	2	2	2	2	3	3	4	5
2100	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3	3	4	5
2150	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3	3	4	5
2200	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3	4	5
2250	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	3	4	4
2300	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	3	4	4
2350	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	3	4	4
2400	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	3	4	4
2450	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	3	4	4
2500	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4	4
2550	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4	4
2600	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4	4
2650	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4	4
2700	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4	4
2750	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4	4
2800	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4	4
2850	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4	4
2900	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	3	4
2950	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	3	4
3000	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	3	4
3050	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	3	4
3100	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4
3150	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	4
3200	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	4
3250	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	4
3300	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	4
3350	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	4
3400	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4
3450	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4
3500	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4
3550	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4
3600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
3950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4
4000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4

FACULTY OF ENGINEERING
AND ARCHITECTURE

GHENT
UNIVERSITY