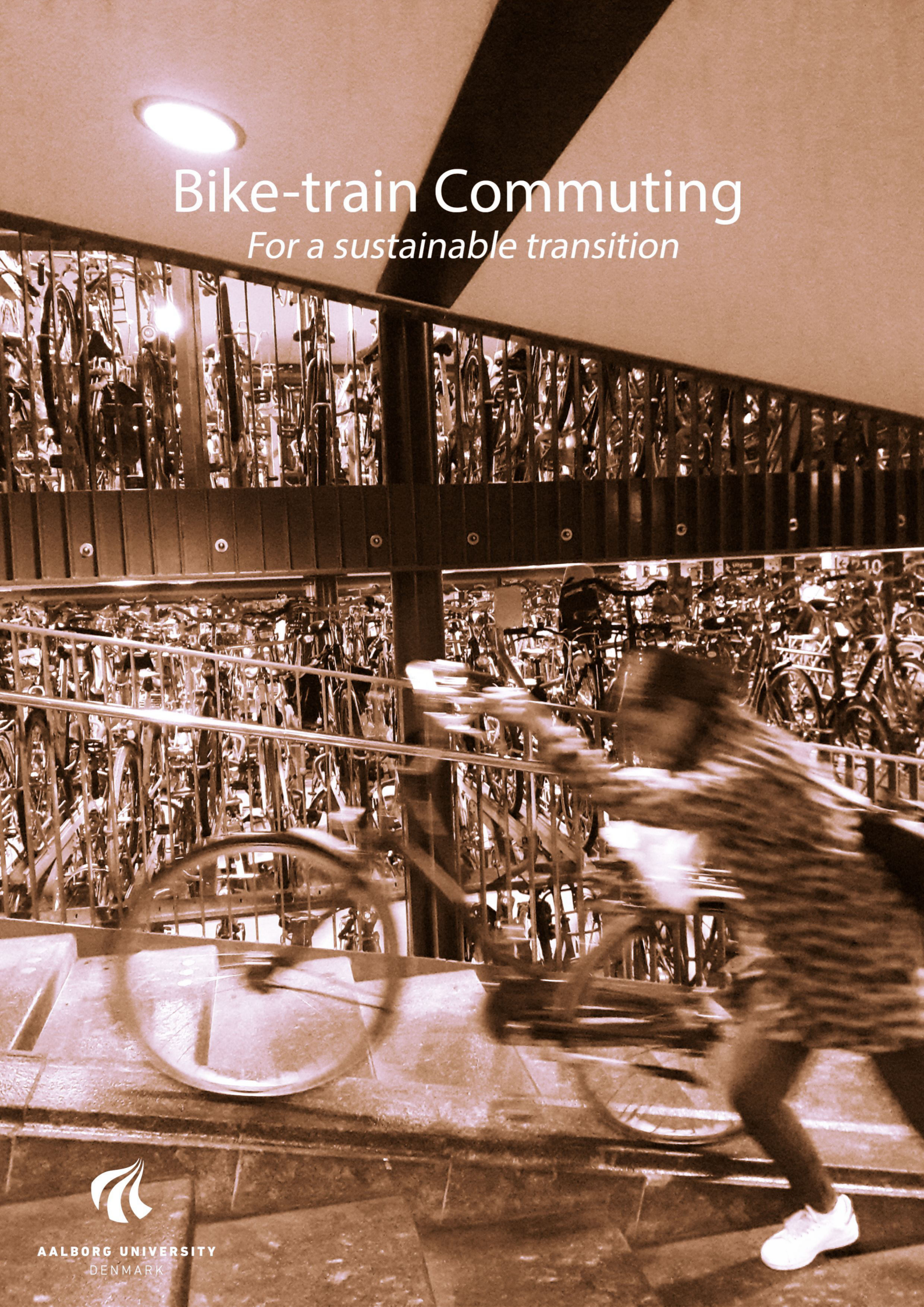
Bike-train Commuting

For a sustainable transition



AALBORG UNIVERSITY
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Bike-train Commuting for a Sustainable Transition

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ABSTRACT

The implications of a car dependent society are becoming increasingly severe with congestion, pollution, carbon emission and health issues being some of the derivative effects. Thus, a sustainable transition of the transport system is necessary. In this thesis, we will investigate the combination of bicycle and train as a sustainable alternative to automobile commuting in the Capital Region of Denmark.

The research topic of the thesis is instigated in a collaboration with the Cycle Superhighway Secretariat, which currently are facilitating a project about intermodal commute in the capital region. We have taken a practice theory approach to examining the mobility patterns of bike-train commuters to gain a deeper understanding of the policy interventions beneficial to support the mode.
To do so, we have analyzed two different commuting questionnaires, held 14 semi-structured interviews with bike-train users, done observational studies at nine stations and held five expert interviews with both planners and researchers of the topic. Furthermore, we have been on a research trip to The Netherlands to see how the mode is supported in other contexts. This have resulted in a scientific article about the mobility practices of bike-train commuters, a visual analysis of how stations can be improved to accommodate the bike-train practice and finally an essay which discusses under which conditions the bike-train mode can contribute to a sustainable transition of the transport system.
We have found that the bike-train users are by no means a uniform group, but a distinction can be made in how far the users travel on the bicycle part of their intermodal commute. Here different compositions of bike-train travel require different elements in the commuting practice. We suggest that the first course of action to support the bike-train mode could be upgrading select transit hubs to accommodate the user group and discuss how the mode in a long term perspective can be established and become a viable alternative to the car in a sustainable transition of the transport system.

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1 INTRODUCTION

This thesis is a result of a collaboration between The Sustainable Cities Master Program at Aalborg University in Copenhagen and the Cycle Superhighway Secretariat (CSS) of the Capital Region of Denmark. The objective of the collaboration has been to gain a deeper understanding of the cyclists who combine bicycle and public transport and thereby identify how the mode can be supported. This knowledge contributes to an ongoing project about intermodal trips in the Capital Region of Denmark facilitated by the CSS. The purpose of the project is to support the mobility practices of intermodal cyclists, and to promote the mode to other potential users. The CSS is a collaboration between 23 municipalities and the capital region. The general assignment of the CSS is to coordinate the upgrade of current bicycle infrastructure in the capital region to bicycle highways; a concept promoting bicycle commuting by offering a network of high quality routes that ensures flow (Villien 2018).

1.1 A Car Dependent Region

The technology of the car has had a substantial impact on how cities have developed during the last century (Dennis & Urry 2009). Danish cities have since the 60's been transformed to accommodate the automobile which in many urban areas have resulted in suburban sprawl and a fragmentation of social obligations (Jørgensen 2001). Numerous externalities have emerged in the wake of the car such as congestion, carbon emissions, traffic accidents, obesity and air pollution (Kenworthy & Newman 2015). These issues emphasize the need for change, and for a new sustainable mobility paradigm to move beyond the car dominated transport policy of today (Banister 2008). According to Kenworthy & Newman (2015) a sustainable transport system creates a more livable city, reduce transport related emissions, and result in a more resilient economy that is not dependent on fossil fuels. Due to the externalities of the car, cities are once again prioritizing former more sustainable transport modes such as the bicycle and public transport (Kenworthy & Newman 2015).

Nevertheless, automobility is still dominating in the Capital Region of Denmark, despite of initiatives supporting more sustainable modes. The new report "Mobilitet for fremtiden" (Mobility of the future) initiated by the Ministry of Transport, Building and Housing predict that congestion in the metropolitan area of Copenhagen will intensify as the car traffic will increase with 16 % until 2030. Time spend in rush hour traffic will increase on the main roads with 100-149 % by 2030 in the capital area and the surrounding suburban areas (Ekspertgruppen Mobilitet for Fremtiden 2018). The increase in congestion is primarily due to a line of proposed motorway projects, an increase of inhabitants, and the expected automatization of cars. In the capital region 10 major stretches of motorway are planned in the following decades (Region Hovedstaden 2018).
Today 46 % of all trips in the region are made by car a tendency that, based on the current predictions, seem unlikely to change (Transportministeriet 2013). The predicted increase in congestion may be attributed to the national governments lack of action to limit the motorization in Denmark. New infrastructure expanding the motorway network is still being discussed as a valid solution to solve future issues of congestion. The restriction of cars is not proposed in the new national report "Mobilitet for fremtiden" (Mobility of the future) and

national government initiatives such as removing the subsidies to electric cars and reducing the cost of conventional cars are clearly an endorsement of automobility (Ekspertgruppen Mobilitet for Fremtiden 2018; Dengsøe 2017). The existing transport policy in the metropolitan region of Copenhagen does not seem to deal with the key externalities of the car such as health risks and carbon emissions.

1.2 The Potential of the Bike-train Mode in the Capital Region of Denmark

The purpose of this thesis is to propose an alternative trajectory to car based mobility. Drawing on inspiration from a sustainable transition perspective, we problematize and propose a radical socio-technical change to the issues concerning the sustainability of the transport system (Watson 2012; Elzen & Wieczorek 2005). In a setting where the dominant socio-technical system is the car (Dennis & Urry 2009), and the current predict and provide paradigm in Danish transport planning cannot deliver alternative solutions, we investigate the bike-train mode as a potential alternative mode of transportation. The bike-train mode is a combination of the stand-alone bicycle chain and the stand-alone transit chain. Thus, the bike-train mode can be composed in several different ways as it can include bicycle trip elements either before or after, or on both sides of the transit (Kager et al. 2016). The aim of our thesis is to identify ways to support the combination of bicycle and train, which despite of being a topic in transport policy the last century, has not received the same attention and political support as automobility (Pedersen & Jørgensen 2001). In the following we will argue why we consider the bike-train mode as a possible alternative to the unsustainable mobility patterns in the Capital Region of Denmark today.

1.2.1 The Bike-train Mode – a Sustainable and Competitive Alternative?

Public transportation on rails emit substantially less CO2 compared to the car, while cycling has no emissions, see table 1. Furthermore, the reduced societal cost of time lost in congestion and the health benefits of the bike make both modes viable alternatives to the car in a transition towards a more sustainable transport system, see table 1.

	Carbon emissions *CO2 per person km (g)*	**Air pollution** *Particles per km (Mg)*	**Congestion Cost** *DKK per km*	**Health** *Decrease in mortality rate (%)*
Car	126	5,5	0,24	0
Bus	85	4,8	0,45	0
Metro	52	0	0	0
Regional train	44	9,9	0	0
InterCity train	29	0-2,1	0	0
S-train	25	0	0	0
Bicycle	0	0	0	-28 %

Table 1 Own production based on: (Trafikstyrelsen 2010; Transport & Energi Ministeriet 2006; Transportministeriet n.d.; Motion & Ernæringsrådet. 2007)

The fragmentation of the city caused by the automobile has increased the distance we travel creating a self-perpetuating effect as we become dependent on the speed of the car to handle the series of task in our everyday lives. The car's ability to cover distances at high speed and provide individual movement sustain the unsustainable mobility practices in the Capital Region of Denmark (Dennis & Urry 2009). When the bicycle and the train are treated individually, the two modes cannot compete on speed compared to the car, see figure 1. The bicycle has an average speed of 17.5-20 km/h (COWI 2012a) which makes its speed incomparable to the car. The train on the other hand have a substantially faster average speed, spanning from 40km/h-80km/h (Metroselskabet 2018; DSB 2016a), which in most cases are very competitive with the car. However, the train is rarely a door-to-door transport option like the car. The time it takes to walk to the station, travel on the train, and walk to the destination, makes this mode less competitive to the car as well. But, when the two modes (bicycle and train) are combined on a trip the speed from origin to destination result in a competitive alternative to the car, see figure 1. For this reason, among others Kager et al. (2016) argues that the combination of bicycle and train should be seen and treated as a mode of its own due to the general utility it possesses. To compete with the car the factor of speed is crucial when comparing alternative modes, as it allows the user to carry out practices at the same rate in their busy everyday life (Dennis & Urry 2009).

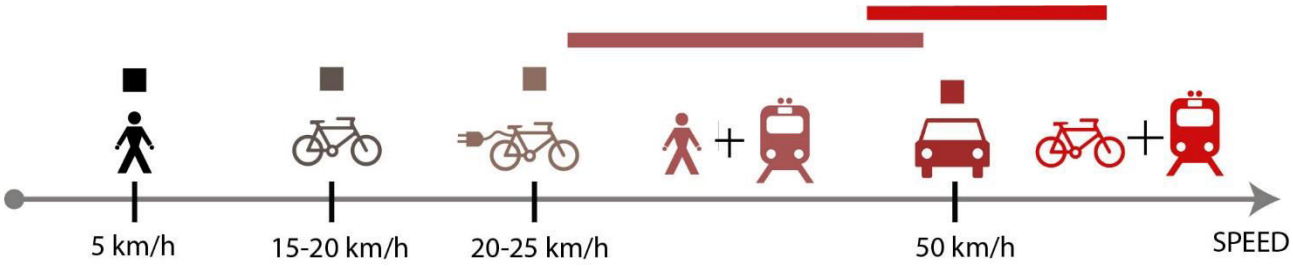
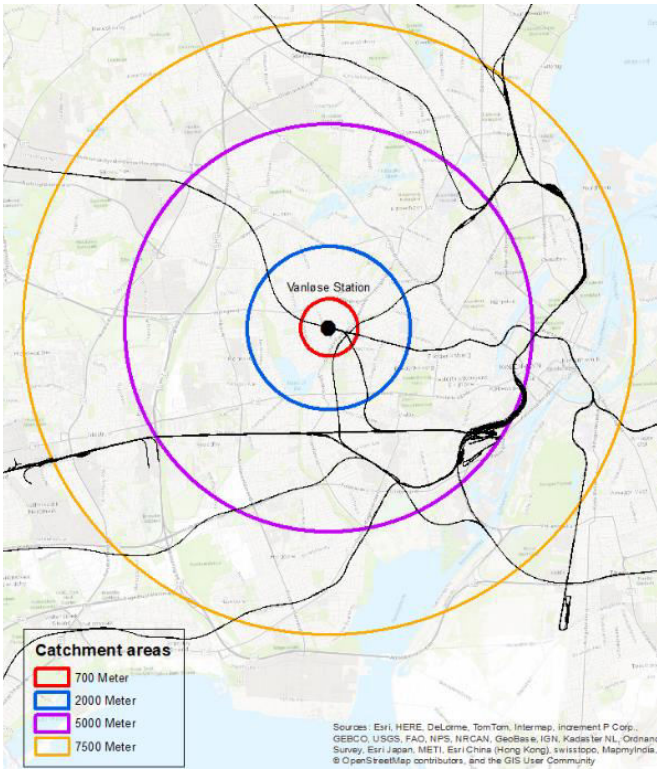


Figure 1 illustrate the speed of the individual modes and the competitiveness of the bike-train mode combined. The average speed of the car is not the actual speed, but the speed when delays in congestion is deducted (Trafikstyrelsen 2009; Cyklistforbundet 2015; Metroselskabet 2018; DSB 2016a; COWI 2012b). Own production.

The technology of the automobile has individualized the mobility patterns of our daily life and increased the flexibility of the transport system (Dennis & Urry 2009). The bicycle is therefore a crucial part of the bike-train mode as it increases the flexibility of public transport and adds an element of individual movement (Kager et al. 2016). The catchment area of the station is significantly increased when the bicycle is used as a feeder mode. In Denmark the catchment area of a station is often considered to be a radius of 700 meters, as that is the distance most pedestrians can travel in 10 minutes. However, on a bicycle this range is increased to 2000 meters resulting in a catchment area 8 times larger than the pedestrians, thus increasing the potential user group significantly (Trafikstyrelsen 2009). In the Netherlands it is argued that the catchment area for bicyclists is larger as they define it as a 5000 meter radius, and even operate with a potential catchment area of a 7500 meter radius (KiM 2014), see map 1. This makes the Danish catchment area estimation look rather cautious, but it could also reflect the different bicycle culture in the Netherlands or a better network of infrastructure around stations. However, Krygsman et al. (2004) find the Dutch catchment areas to be rather overestimated, as only 30% are willing to have a longer travel time than 10 minutes, which is also the backbone of the Danish model. The bicycle will however, always increase the catchment area for stations thus increasing the flexibility for the bike-train user.

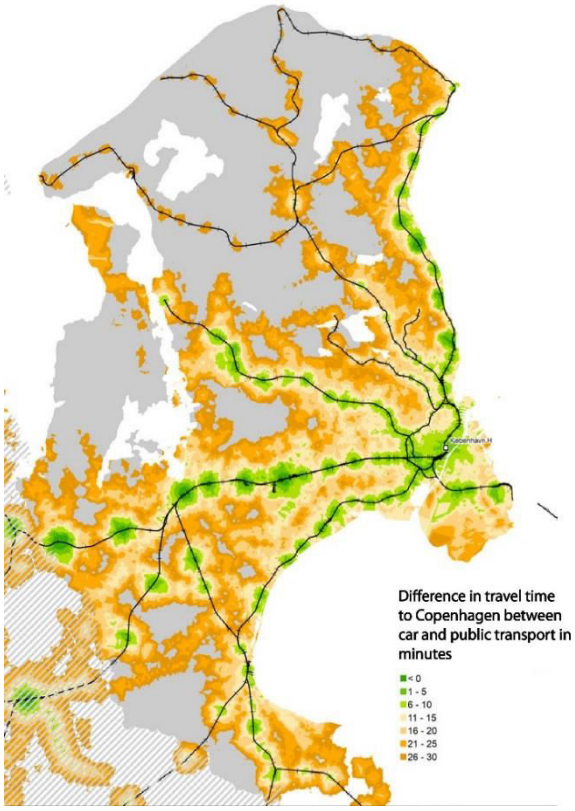


Map 1 the catchment area of pedestrians (700 m) and bicyclists (2000 m) considering 10-minute travel time to station (Danish standards) and bicycle catchment area (5000 m) and potential bicycle catchment area (7500 m) (Dutch standards). Own production.

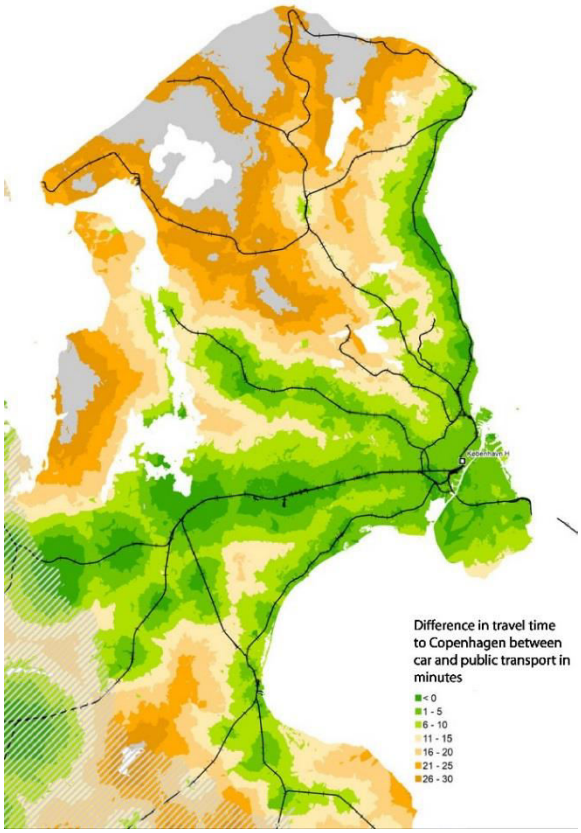
1.2.2 Transit-Oriented Development is Key

A unique characteristic of the capital region that is worth mentioning in the context of the bike train-mode is the "Fingerplan". *The Fingerplan* dating back from 1947 is a strategic development plan for Copenhagen, which dictates that the city can only expand through certain corridors the “fingers”, ensuring green recreational areas in between. The bone of the fingers are the S-train lines, which should provide sufficient public transport for the residents living in the fingers. The plan has limited urban sprawl in the region and have ensured that almost everyone have access to public transportation (Erhvervsstyrelsen 2017). The transit-oriented development strategy (The Fingerplan) of the Capital Region of Denmark has resulted in 87% of all residents in region living and working within a 2 km radius of a train station, which currently is considered the catchment area of the bicycle (Region Hovedstaden 2013). The conditions of the capital region are therefore, in large parts ideal for the bike-train mode; there is a high population density, 711/km^2 (Danmarks Statistik 2018) a rail network with 175 individual train - and metro stations and 206 km bicycle highway along with an extensive network of normal bike lanes (Region Hovedstaden 2016).

The fact that the bike-train mode can compete with the private car in terms of speed in the region is highlighted in map 2 & 3 below. Map 3 emphasizes that the bicycle as a feeder mode of public transportation in the Capital Region of Denmark is a serious competitive alternative to the car. The two maps show the difference in travel time to Copenhagen Central Station between car and public transport in minutes.



Map 2 Difference in travel time between public transport and car from all places in the capital city of Copenhagen H with walking as a feeder mode (Region Hovedstaden 2018).



Map 3 Difference in travel time between public transport and car from all places in the capital city of Copenhagen H with cycling as a feeder mode (Region Hovedstaden 2018).

The bicycle combined with public transport make the trip significant faster when it comes to door-to-door transport. However, this does not change the basic mobility challenge of public transport further out in less populated areas (Region Hovedstaden 2018).

Despite the potential for the bike-train mode in the Capital Region of Denmark, only 2.4 % of all trips within the region are bike-train trips, see figure 2. The bike-train travel in the region primarily consists of commuter trips which can be attributed to the transit-oriented development in the *Fingerplan* (Transportministeriet 2013). The *Fingerplan*, has affected the regional labor market were most jobs in the region, placed in the city of Copenhagen, can be accessed through the railway corridors allowing residents to commute long distances to and from the capital on a daily basis, see map 3 (Region Hovedstaden 2015). However, despite of the modes favorable conditions 46 % of all commuting trips in the capital region are made by car, which especially dominate on distances over 10 kilometers (Danske Regioner 2017; DTU 2014). We will therefore investigate how bike-train commuting can be supported as an alternative mobility pattern to unsustainable automobility.

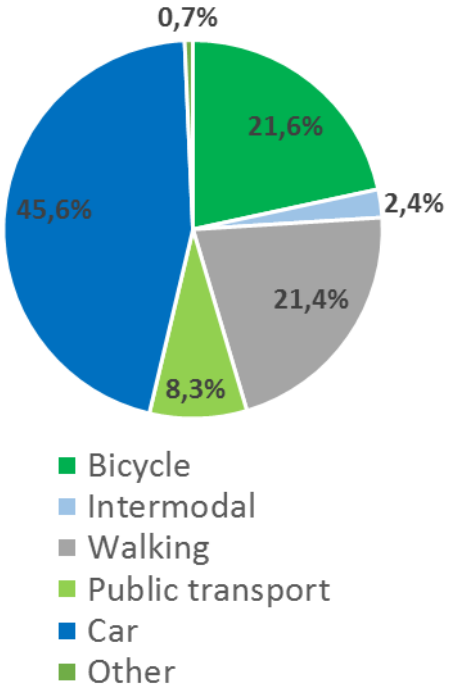
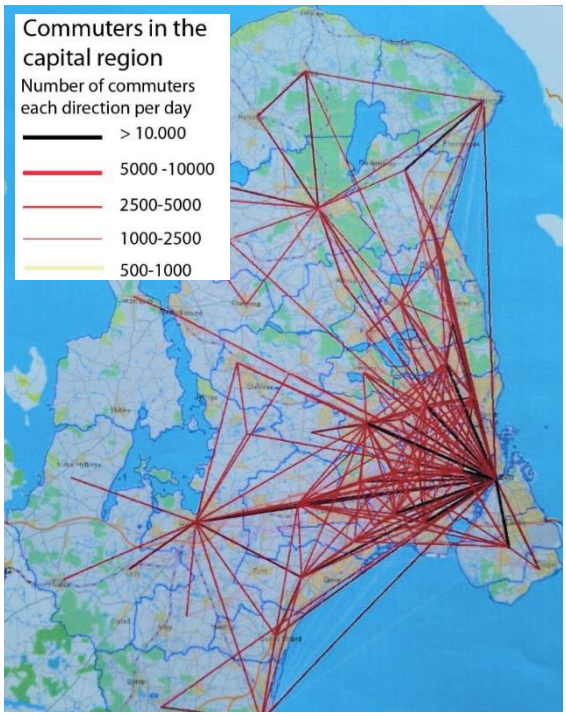


Figure 2 share of modes used for trips of the capital region residence. "Intermodal" accounts for bike-train, bus-train and car-train. Own figure based on; (Region Hovedstaden 2016)



Map 4 Displaying commuters per day in each direction in the Capital Region of Denmark (Secretariat for Supercykelstier 2018)

1.2.3 Overlooked and Forgotten in Transport Policy?

The bike-train mode has been a topic of discussion for almost 120 years in Denmark, however the mode is still struggling to transition to an established socio-technical system. The discussion and planning for the mode can be seen in two "waves" one spanning from the early 1900's to the 1950's and the other spanning from the 1980's to present day. The two waves display many similarities, as its growth have been gradual and bottom-up based and many actors have been reluctant in accepting and planning for the bike-train mode (Pedersen & Jørgensen 2001). This section will focus on the latter and more current wave.

During the 80's there was a growing demand to bring the bicycle along on the train. The cyclist association was the main actor who articulated this need to the National Danish Train Company (DSB), who were reluctant in accepting the demand at first. Their main concern was that bringing the bicycle on the train would cause delays and irritation to their other customers. However, in 1984 the minister of transport published a report which stated that customers should be allowed to bring the bicycles on trains and that the parking facilities should be upgraded at select stations, see figure 3 (Pedersen & Jørgensen 2001). This sparked a transition trajectory which have been going on up until present day. As displayed in figure 3, several transport companies, municipalities, bicycle organizations, the state and many test projects have tried to promote the mode. However, policies working against the mode have also pushed the development backwards such as the proposed ban of bicycles on the new light rail, see timeline. The conflicting agendas between the institutions in the transport system might have resulted in the bike-train mode having limited success. No organization exists with the sole purpose of promoting the bike-train mode.

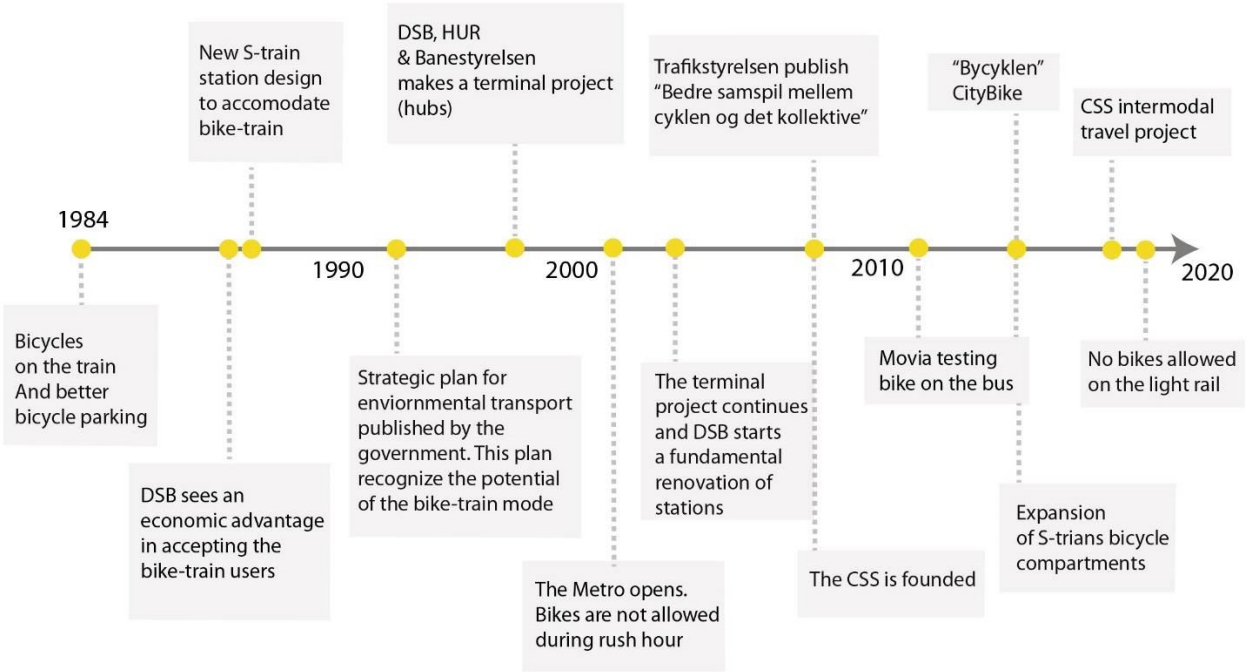


Figure 3 Timeline. (Pedersen & Jørgensen 2001; HUR 2001; Metroselskabet n.d.; HUR 2003; Trafikstyrelsen 2009; Supercykelstier n.d.; Cykeltrafikken 2013; Bycyklen n.d.; Hovedstadens Letbane n.d.) Own production.

1.3 Research Design

During the last 20 years, increased attention and effort have been made to improve the conditions for the bike-train mode by bicycle organizations, traffic companies, municipalities, the capital region and the state. Despite of the attention the bike-train mode has received by the institutions in the current transport system the mode represents an insignificant share of the infrastructure investments (Pedersen & Jørgensen 2001). In their study of the multimodal patterns of Danish cyclists Olafsson et al. (2016) argue that:

> *"Multimodality has been a strategic topic in transport planning for decades, but it can be argued that indicators and infrastructure policies remain essentially uni-modal, targeting one mode at a time. Thus, clarifying, representing, and imagining the ways in which cycling interacts with and depends on other transport modes should provide a new and valuable basis for the development of policies to promote cycling and sustainable mobility." (Olafsson et al. 2016: 129)*

According to Olafsson et al. (2016) the current transport policies will have difficulties targeting intermodal travel as long as institutions in the transport system are tied to a singular transport technology. The bike-train mode could offer a sustainable alternative to automobility if not for a lack of political support and knowledge concerning intermodal travel. Depicting the intermodal behavior of bike-train commuters seem essential if future transport policies to support a sustainable transition. The overall aim of our thesis is therefore to investigate the following overarching problem statement:

How can bike-train commuting be supported and contribute to a sustainable transition of the transport system in the Capital Region of Denmark?

As the bike-train mode has emerged as a bottom-up system several knowledge gaps exists concerning the users of the mode. Viewing the bike-train mode as a singular transport system raises a number of questions that former studies of the separate transport modes *train* or *bicycle* might not be equipped to answer. According to Kager et al. (2016) there are several implications of viewing the mode as a singular system;

> *"How does this bicycle–train mode together with its two subsystems (stand-alone bicycle and traditional transit use) allow for distinct bicycle–train-based mobility practices? In particular, we expect distinct sensitivity for distance […] and implications on activity scheduling and activity chaining. […] If we accept that the bicycle–train system is a distinctive travel option, we need to develop a better understanding of how it relates to these characteristics. In other words, we need to catch up with insights in the relationships between individual and societal characteristics and modal choice that have been researched for the other, 'traditional' transport modes" (Kager et al. 2016: 218).*

Following this argument, the need to know more about the mobility practices of bike-train users seems essential if the mode is to be supported and contribute to a sustainable transition. According to Watson (2012) a practice theory perspective can help us gain a deeper understanding of what is going on within the socio-technical system, as practice theory can provide insights to what individuals *do* within the system where they perform their practice. When studying the elements of a practice opportunities for interventions in a current socio-technical system can be identified (Watson 2012). The purpose of our thesis is therefore to investigate the mobility practices of bike-train commuters in the Capital Region of Denmark. This is done to pinpoint the societal structures influencing the practice of bike-train commuting which is key in the development of policies aiming to promote the bike-train mode. These considerations inspire the investigation of the following sub-question:

> *1: What characterize the mobility practices of bike-train commuters in the Capital Region of Denmark and how can the mode be supported through policy?*

We investigate this research question from different angles with a mixed methods approach, combining knowledge obtained from questionnaires and in-depth interviews with bike-train commuters in the capital region. The questionnaires give us insight in the mobility patterns of the user group while the in-depth interviews enable us to understand the elements producing the mobility practice, see figure 4 part 1. Opposite to the quantitative approach often applied in transport research a practice theory perspective requires qualitative methods to understand how a practice is produced. In-depth interviews provide a broader picture than the quantitative method, as the actions of the users are not seen isolated but rather in relation to the context where the action is carried out (Halkier et al. 2011; Cass & Faulconbridge 2015). The methods supplement each other in the identification of policy interventions, see figure 4.

We argue that the bike-train mode in theory might be competitive with the automobile at least in a context similar to The Capital Region of Denmark. However, to our knowledge, no study has investigated under which factual condition this bike-train mode might actually compete with the car. Kager et al. (2016) argue that this knowledge gap is critical: *"Further illustration and exploration under which conditions this [bike-train mode ed.] competitiveness could be increased, is an obvious and urgent direction for future research, with evident implications for a transition to a more sustainable urban transport system"* (Kager et al. 2016). The findings from the first part of our thesis see figure 4, suggest that the conditions of bike-train commuting needs to be improved on different scales to enable a sustainable transition. The conditions must first of all be improved on a local scale where the practice takes place to recraft and substitute unsustainable mobility practices, see section 6.3 substituting practices in the scientific article. According to Kuijer (2014) the design of materials can directly influence how practices are produced and performed. The second part of our thesis will therefore, with basis in the knowledge obtained about the user group in the prior sub-question, investigate how we through physical improvements can increase the

competitiveness of the mode. To improve the conditions for bike-train commuting we will consider how the materials but also meanings and skills attributed with the bike-train practice can be supported, see the following research question:

> *2: How can design on a local scale support the mobility practice of bike-train commuters and where should these improvements be carried out?*

In this part of the thesis we build on our previous mapping of bike-train practices where several tensions and suggestions of intervention were identified. We operationalize this knowledge in an assessment tool using best practice approaches and user preferences, see figure 4. To identify several potential sites for improvement we use different parameters from our practice analysis in GIS selection. Methods of observation have been utilized to investigate 1) the state of the local conditions and 2) the possible opportunities for change. This result in a visual analysis drawing on inspiration from a research trip to the Netherlands, our practice analysis, and best-practice examples. The purpose of the visual analysis is to inspire long term and short term improvements in the area, see part 2 in figure 4.

In the first part of our thesis, we identify several conditions on a systemic level where different socio-technical structures influence the mode. Despite the value of a practice perspective in identifying the possible interventions in the dominant socio-technical system the theory falls short in creating connections to an institutional level. The theory is often criticized for its inability to offer solutions of how change of practices is embedded in policy and institutions enabling a radical transition of the current socio-technical system (Watson 2012; Strengers & Maller 2015). In the last part of our thesis we therefore mainly draw on a transition perspective to discuss the desired conditions of the future and if the current institutions of the transport system can facilitate the transition. Leading to the third and final research question of the thesis:

> *3: Under which conditions can the bike-train mode become an established socio-technical system leading to a sustainable transition?*

The knowledge obtained in the two prior research questions is supplemented with several expert and stakeholder interviews to discuss under which conditions the bike-train mode can be promoted. The stakeholder interviews give an analytic insight in the current rules and position of the institutions of the bicycle and train system, see part 3 in figure 4. Semi-structured interviews with researchers from the Netherlands help us compare the transition trajectory of the bike-train mode in the two countries. This give valuable insights into the possible future components of an established bike-train system.

The three parts of the analysis are presented in different formats to contribute with knowledge of the bike-train system to fellow researchers and inspire planners. Each part of our thesis addresses the bike-train mode from a different angle and can stand a part but together the knowledge obtained in the different parts form a whole, see figure 4.

Some insights can be obtained through observation while others can be obtained through interviews. As figure 4 below describes we have chosen to use a wider array of methods for the different parts of this thesis. We decided to do so, not only to understand better the various aspects of the bike-train commuting practice, but also to operationalize the acquired knowledge into efforts, which can support a sustainable transition of the socio-technical system.
A more thorough description of our methodological considerations and procedures can be found in, 3 Methodology, in the scientific article and appendix I in the visual analysis.

PART 1 – Scientific Paper

The Nature of Intermodal Commute: The Mobility Practices of Bike-train Users in the Capital Region of Denmark

Theory: A practice theory perspective

Allow us to identify the elements producing the practice of bike-train commuting. Based on identified tensions in the practice different ways of reconfiguring policy targeting bike-train mode is suggested.

Methodology: Interviews and questionnaire

The empirical base of the study contains 14 interviews with bike-train commuters and two independent questionnaires consisting of a total of 1552 respondents. The mixing of methods allows us to view the mobility patterns of the bike-train users from different angles. The qualitative interviews give unique insights in the sequence of practices that influence commuting and the societal structures that help produce the practice of the bike-train travel.

PART 2 – Visual Analysis

Future bike-train hubs

Theory: A practice theory perspective

Inspired by the identified tensions in the practice of bike-train commuters we point to key conditions to support the bike-train practice through design. A practice approach thereby helps us evaluate the current conditions of an area and determine design improvements.

Methodology: observation, literature study, GIS analysis, research trip

The user group insights obtained through interviews and questionnaires is the foundation of the visual analysis. A GIS analysis inspired by the mobility patterns of the bike-train users help us determine where design improvement should take place to promote bike-train commute. Besides the knowledge obtained about the elements producing the bike-train practice a literature study of best bike-train practice solutions contribute to the development of an assessment tool. We utilize the assessment tool by testing and observation studies of local conditions. The empirical data of the bike-train users and a research trip to the Netherlands inspired new design suggestions.

PART 3 – Essay

Promoting bike-train commuting – conditions for a sustainable transition

Theory: A transition approach and practice theory

Allow us to discuss the current conditions of socio-technical systems in a bike-train perspective and suggest future settings to support the bike-train mode and a sustainable transition of the transport system. In the discussion of the sociotechnical system a practice theory outlook enables us to understand the practices which makes up the system and how the institutions should accommodate them.

Methods: Interviews, questionnaires, literature studies, stakeholder interviews and expert interviews

Based on our data sample of bike-train users, different themes concerning the promotion of the mode are unfolded in the discussion. Furthermore, literature studies and interviews with experts are used to discuss the sustainability of the current and future system of the bike-train mode. Stakeholder interviews supplement with knowledge of the position of the current institutions in the socio-technical system.

Stakeholder Interviews:

Jakob Skovgaard Villien, Project Manager, Secretariat for Cycle Superhighways
Anne Pilegaard, Head of the Planning Department, Danish Train Operation Company (DSB)
Wietse Bruggink, Planner of bicycle highways, Region of Gelderland

Expert interviews:

Marco Te Brömmelstroet, researcher in bike-train mode, University of Amsterdam
George Lui, researcher in bicycle highways, Eindhoven University of Technology

Figure 4: Structure diagram explaining theory and method for each of the three parts.

PART I - Scientific Article

The Nature of Intermodal Commute: the Mobility Practices of Bike-train Users in the Capital Region of Denmark

8 JUNE 2018

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Abstract

In the decarbonization of the current transport system the combination of bicycle and public transport is, despite its potential to a sustainable transition, a somewhat overlooked solution. We argue that the combination of the two modes embody specific mobility practices and therefore should be treated as such in future transport policies. In this paper we take a practice theory perspective to identify possible policy intervention which can accelerate a transition towards bike-train commuting. By analyzing quantitative and qualitative data about the mobility practices of bike-train commuters in the Capital Region of Denmark we investigate the current elements enabling the practice of bike-train commuting. Our study suggests that different compositions of the bike-train mode impact cycling patterns resulting in both short and long distances on bicycle. We show that the complex compositions of intermodal trips are not only affected by the different elements in bike-train practices but also by the sequences of which practices of everyday life interlock. This lead us to argue that future policy interventions need to be reconfigured to maintain, recraft and substitute carbon based commuting with bike-train mobility. This means increasing the flexibility in social institutions to mitigate temporal and spatial pressure, improving the conditions under which the practice is performed in the bike-train system and reducing the privileges of automobile.

Preface

The following analysis is one of three parts of our Master Thesis concerning bike-train commuters in the Capital Region of Denmark. The analysis is presented in the format of a scientific paper, and we investigate the mobility practices of the bike-train users and pinpoint opportunities for a sustainable transition. The subject of our Master Thesis is inspired by a collaboration between the Sustainable Cities Master Program at Aalborg University and the Cycle Superhighway Secretariat in the Capital Region of Denmark. The purpose of the following paper is to contribute with knowledge of the bike-train user and provide inspiration to policy solutions in the Cycle Superhighway Secretariat's work with promoting intermodal trips in the Region of Copenhagen.

1. Introduction

Cities are under increasing pressure to reduce the carbon footprint of their inhabitants and find ways to cope with their unsustainable mobility practices. The decarbonization of the transport system is an urgent issue that cities around the globe try to address by prioritizing sustainable modes of transport such as cycling and public transportation (Kenworthy & Newman 2015). A possible, but largely overlooked, solution is an integration of the bicycle and public transport as the two modes combined can compete on speed and flexibility as a sustainable alternative to the individual motorized modes (Kager et al. 2016). However, for decades urban life has been adapted to the automobile. Today, workplaces, services, social engagements, and residential areas are fragmented across the urban landscape. The unsustainable mobility patterns of today are influenced by these societal structures (Urry 2004). The purpose of this paper is therefore to discuss how the mobility patterns of current bike-train users are enabled. We take a practice theory perspective to investigate how their practices are produced and discuss how this knowledge might be used in a transition towards sustainable mobility.

The study is a part of the Sustainable Cities Master Program of Aalborg University in Copenhagen and is instigated in a collaboration with the Cycle Superhighway Secretariat (CSS) in the Capital Region of Denmark. CSS is mainly focused on bicycle commuters and are working to promote bike-train travels in the region. However, the subject of bike-train travels is still an underdeveloped field of research (Kager et al. 2016; Olafsson et al. 2016).

In later years, an increasing amount of research have suggested that travel behavior is more complex than previously described by traditional transport planning. Studies of multimodality describe how mode choice might differ during the week in accordance to the activity or the transport options available, while the study of intermodal travel describes combination of different transport modes during a single trip (Clifton & Muhs 2012; Buehler & Hamre 2014a; Olafsson et al. 2016; Jonuschat et al. 2015). According to findings of Olafsson et al. (2016) few Danes are unimodal; only using one mode of transport for all the daily transport needs. Bicycles in particular are combined with other modes of transport and are an important feeder mode to public transport (Olafsson et al. 2016). In the Capital Region of Denmark close to 1 in 9 bicycle journeys are combined with public transport (Capital Region of Denmark 2016). During the last decade, an increasing amount of research have investigated the potential of the bike-train combination. The spatial reach of the bike-train mode and the ability to cover long distances at high speed, as well as the achieved accessibility of the bike, enable this mode to replace car trips and increase the share of environmentally sustainable trips (Kager et al. 2016; Kager et al. 2015; Kager & Harms 2017).

The mobility practices attached to different transport modes have been investigated by several practice authors (such as Shove et al. 2012; Cass & Faulconbridge 2015) and numerous studies have investigated travel behavior among the user groups of either the *bicycle* or the *train* (Harms & Brömmelstroet 2014; Hansen & Nielsen 2014; Buehler & Hamre 2014 b; Næss & Jensen 2005; Freudendal-Pedersen 2015). Overall, behavioral studies of transport users have investigated each transport option separately and a knowledge gap

exists on multi-modal travel patterns (Clifton & Muhs 2012). Kager et al. (2016) outline several knowledge gaps and future research opportunities in their paper *"Characterisation of and reflections on the synergy of bicycles and public transport"*, which treats the bike-train combination as a separate transport system. Some of the identified gaps include; an investigation of the distinct mobility practices of the bike-train users and how the transit system can be designed to optimize the user experience and unleash the full potential of bike-train travel.

The system of the bike-train mode in regard to catchment areas, the potential of different type of trains and the system main components have been identified in prior research (Keijer & Rietveld 2000; Krygsman & Dijst 2001; Geurs et al. 2016; Puello & Geurs 2015; Krygsman et al. 2004). According to Keijler & Rietveld (2000), the bike-train mode is mainly attractive on long distances and the bicycle is mainly used as a feeder mode to the station. The synergy between the two modes have the ability to compete with the car on speed and flexibility (Kager et al. 2016). In their article *A multi-modal network approach to model public transport accessibility impacts of bicycle-train integration policies* (2016) Geurs et al. argue that the integration of the bicycle and train is a cost-efficient way to expand public transport catchment areas, and increase the flexibility of the public transport system. Nevertheless, to our knowledge, no study of the mobility practices of bike-train users exists. This knowledge is crucial in regard to promoting and developing the bike-train practice in the future;

> *"Multimodality has been a strategic topic in transport planning for decades, but it can be argued that indicators and infrastructure policies remain essentially uni-modal, targeting one mode at a time. The everyday life in which mode use is embedded, on the other hand, is essentially multimodal. Thus, clarifying, representing, and imagining the ways in which cycling interacts with and depends on other transport modes should provide a new and valuable basis for the development of policies to promote cycling and sustainable mobility." (Olafsson et al. 2016: 129)*

Therefore, there is a need for knowledge of the complex composition of transport modes, how these modes of transport affect mobility practices and finally how the bike-train system can be promoted as its own transport system. The aim of this study is to investigate the current mobility practices of bike-train users and discuss how this insight can inspire solutions to promote the mode through policy.

1.1 The Bicycle-train Commute in a Practice Perspective

The Value of a Practice Perspective

Our aim with using practice theory is to identify the societal structures that can support an increase in producing and reproducing the practice of bike-train commuting. A practice perspective allows us to understand the interconnections between the everyday practice of commuting, social institutions, and spatial infrastructure (Spurling et al. 2013). From a practice theory perspective, the bike-train trips are a distinctive practice in its own and this study will outline how the user group of the bike-train mode have unique competences,

materialities and meanings associated with their transport. According to Kuijer (2014) opportunities for change can be identified by studying the elements of a practice. One way of revealing tensions in the bike-train practice can be by returning to the moment where the practice became dominant. "*In such transformational moments, advantages and disadvantages of the practice are discussed widely"* (Kuijer 2014: 63). The origin of the user's bike-train practice and the arguments behind this change are therefore an important part of our study. We will show that the internal tensions in the current bike-train practice can help identify trigger points of intervention supporting the recruitment of practitioners to more sustainable mobility practices (Kuijer 2014; Watson 2012). In addition to these reflections, we argue that maintaining current bike-train practices is just as crucial as recruiting new practitioners.

Bike-train Commuters

Prior studies of the bike-train travel pattern in the Netherlands and Denmark suggest that the bike-train mode is primarily used to commute to work or education (Krygsman & Dijst 2001; Transpotministeriet n.d). Approximately 45-49 % of the bike-train trips in Denmark (Transportministeriet n.d.) and 55-67 % of the bike-train trips in the Netherlands are commuting trips (Krygsman & Dijst 2001). The scope of this study is to investigate bike-train commuting, as the practice of this mobility pattern seems to be tied with the specific activity of travelling to work. The practice of bike-train commuting might be significantly different compared to bike-train trips serving other travel purposes as commuting is meaningful because of its end activity (Cass & Faulconbridge 2014). For example, the bike-train commuter might choose to combine modes, so she does not have to bike the entire way and show up sweaty, when arriving at work. Furthermore, the practice of commuting is affected by specific obligations of everyday life and land use policies such as the location of residential areas, schools, shopping and workplaces (Cass & Faulconbridge 2014).

Bike-train Definition

Numerous definitions of multimodal travel behavior exist; the bike-train user might be someone who changes transport modes during the week, make decisions to change modes on the go or someone who combine two or more modes on one trip from the origin to the destination (Kesselring 2006; Lisson et al. 2017; Clifton & Muhs 2012; Olafsson et al. 2016; Jonuschat et al. 2015). In this paper, we propose that a bike-train commute consists of the two materials *the bicycle* and *train* (or train like mode) on a single trip for it to be a specific mobility practice of its own. However, being a bike-train commuter is not determined by how often the commuter chooses to combine modes. The purpose of this study is to examine when and why the bike-train commuter combines the two modes but also when and why they choose not to. To capture the mobility patterns of bike-train users, the definition of a bike-train commuter therefore needs to be relatively flexible. The definition should embrace users who might only commute once a week by bike-train or only some periods of the year, as well as those who do it often or daily.

Following this introduction, the remainder of the paper will start by introducing the context of our study in section 2) while the qualitative and quantitative methods used will be presented in section 3). The other half of the paper is organized around three analytic sections that identify; the elements of the bike-train commuting practice in section 4), the sequence of daily practices interlocking with the practice of bike-train commuting in section 5), and the policy implications of maintaining, recrafting, substituting, and changing how practices interlock in section 6). We conclude and discuss how a practice perspective can give new policy insights in section 7).

2. Context of Study

In the Netherlands, the bike-train mode is the only mode to experience a significant annual growth of 5 %, in number of trips per person (Kager et al. 2016). In past decades, the mode has also experienced an increase in the Capital Region of Denmark. However, the share of bike-train trips has been relatively stable since 2012 where the mode accounted for approximately 2.3 % of all trips in the region (Region Hovedstaden 2014).

In general, commute had a share of 28 % of the kilometers travelled in Denmark in 2014 (DTU 2014). The scope of this study is specifically bike-train commuting in the Capital Region of Denmark as;

- Cars dominate the commute in the Capital Region of Denmark (46.6 %) (Danske Regioner 2017), mainly on distances over 10 km (DTU 2014).
- The average commuter distance is 16,2 km and thereby higher than the preferred distance of non-motorized commuting (Danske Regioner 2015; DTU 2014).
- The increase in bike-train trips seem to have stagnated since 2012 (Capital Region of Copenhagen 2016)

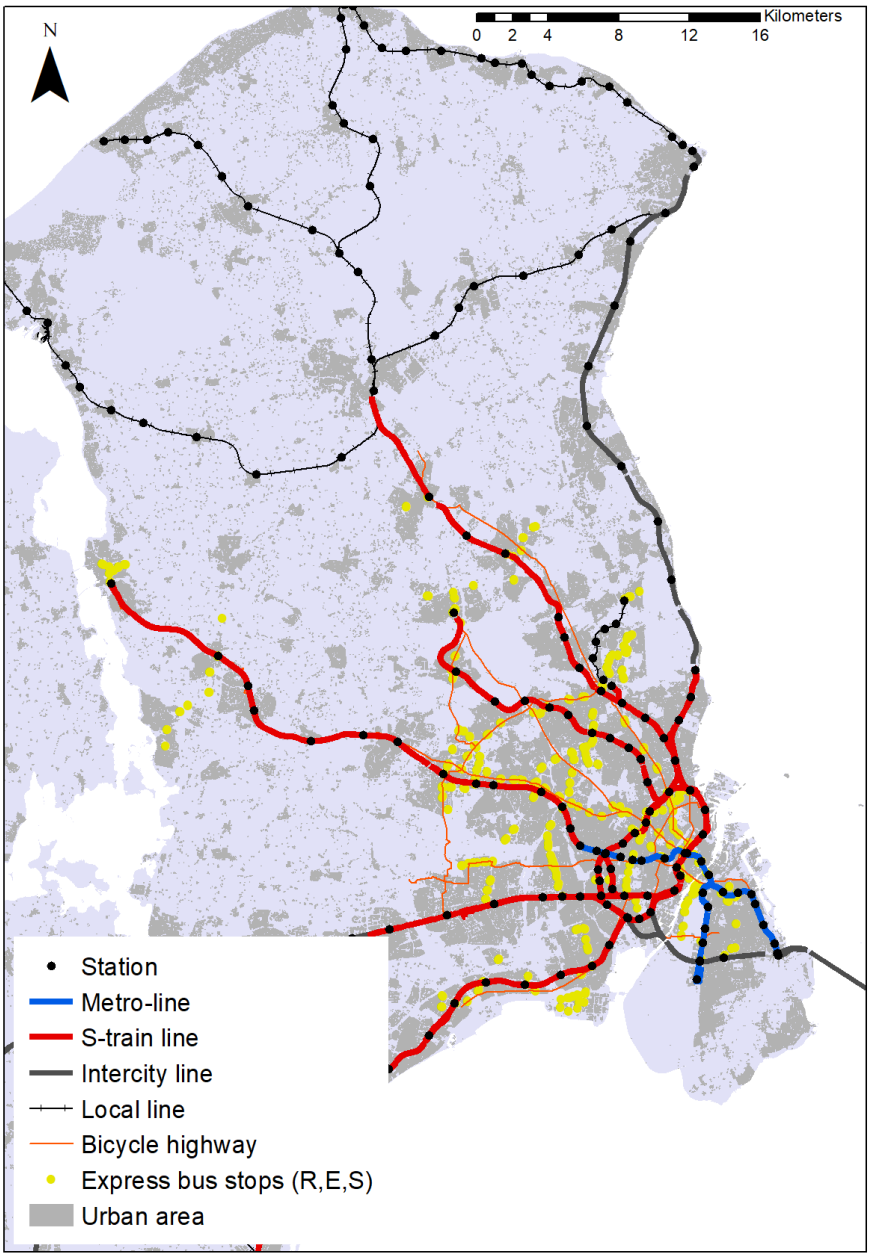
Compared to the contextual conditions in the Netherlands, the Capital Region of Denmark seems to possess potential to expand the share of bike-train trips. Almost the entirety of the residents in the region live and work 4 km from a station, which in the Netherlands is a distance covered by bicycle, see table 1. 30 % of the inhabitants in Denmark live in the Capital Region which makes it the region with the highest population density in the country (Danmarks Statistik 2018).

Table 1: Comparison of bike-train travel patterns		
	The Netherlands	**The Capital Region of Denmark**
Average distance travelled in public transport on an intermodal trip	Metro: 6-7 km (12 %) Bus: 13-20 km (36 %) Train: 48-54 km (45 %)	No data on intermodal commute
Occurring feeder modes according to distance (access and egress)	Walking: 0-2 km Bicycle: 2-4 km Bus: 5< km	Walking: 0-2 km Bicycle: <3 km Bus: 2< km[1]
The bike share as a feeder mode	Access: 47 % Egress: 12 %	Access: 27 % Egress: 10 %[2]
Distance from residence to station	69 % live 5 km from a station	95 % live less than 4 km from a station 97 % work less than 4 km from a station
Population	17.209.846	1.826.010
Population density	414.8/km2	710.98/km2

Table 1 Own prodcution composed of statistic data from: Krygsman & Dijst 2001; Keijer & Rietveld 2000; Krygsman & Dijst 2001; Transportministeriet n.d.; Kager et al. 2016; Statistics Netherlands 2018; Danmarks statistik 2018.

[1] Average distances in Denmark (Transportministeriet n.d.)
[2] 25 % of the Bike-train commuters bring their bike on the train (Transportministeriet n.d.)

The public transport system in the Capital Region consists of the S-train lines connecting the capital of Copenhagen with the suburban area surrounding the city, see map 1. Regional trains connect Copenhagen with the smaller cities scattered across Zealand, and InterCity trains link to Sweden and the rest of Denmark. The city of Copenhagen has two metro lines connecting eastern and western parts of the city. The city busses and metro system are the only place where bicycles are prohibited in peak hours. In all other trains and regional busses, commuters have the opportunity to bring their bike onboard. In the S-train a bicycle can be brought unto the train for free. The S-trains' special bicycle compartments have room for 14 to 28 bicycles in total. In the Capital Region, 205 kilometers of bike path have been upgraded as bicycle highways (Supercykelstier n.d.).



Map 1 Bike-train network of the Capital Region of Denmark (own production).

3. Methodology

The empirical base of this study is composed by the use of mixed methods, specifically questionnaires and in-depth semi-structured interviews withbike-train commuters in the Capital Region of Denmark. The mix of quantitative and qualitative methods enables us to identify general tendencies in the travel patterns of bike-train commuters, but also to reveal the complexity of contextual factors affecting commuting (Yin 2009; Kvale 2007).

3.1 Questionnaires

The data is obtained from two different transport surveys in the Capital Region. The first is a questionnaire (n=433), developed in cooperation with the CSS in their project about intermodal trips in 2018. The second questionnaire (n=15794) is part of a transport survey among the 100 largest companies in the Capital Region of Denmark, provided by Gate 21 from their project "Moving People". The first is a survey directly targeting bike-train commuters, while the second is investigating commuting patterns in general. The questionnaire developed by the CSS was distributed among the volunteer commuter panel "Passagerpulsen", targeting their members in the Capital Region. The questionnaire, developed by Gate 21, was distributed during 2016 and 2017 among the employees of the participating companies.

The CSS questionnaire targeting bike-train commuters covers four main themes; 1) the composition of modes in the daily commute, 2) motivation for combining modes, 3) weekly and seasonal commuting patterns, and 4) the demography of the respondent. The purpose of Gate 21's Moving People questionnaire, targeting commuters in the Capital Region is to discover potentials for the participating companies' mobility management strategies. Here the focus is; 1) commuting patterns of the prior week, 2) the effect of work related errands, 3) satisfaction with the commute, and 4) the effect of the facilities offered at the company, and 5) the demography of the respondents.

The Gate 21 questionnaire asks about the commuting patterns of the participants' prior week. Seasonal variations are therefore not captured in the questionnaire, and we chose to set a minimum requirement of one day of intermodal travel during the week, when collecting our sample of bike-train respondents. This results in data from a total of 1329 bike-train respondents in the Gate 21 survey while 223 of the respondents in the CSS questionnaire combine the bike and train.

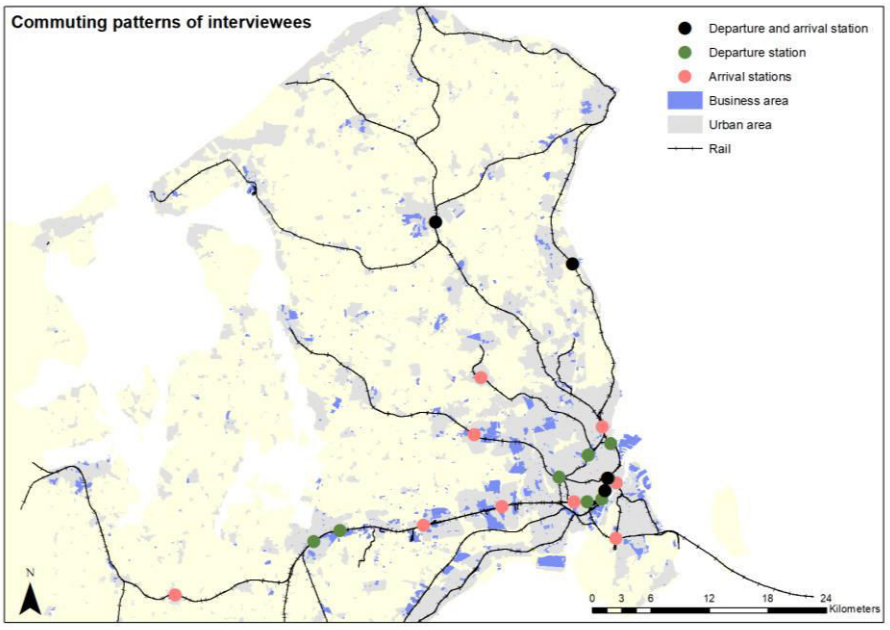
3.2 Interviews

We conducted interviews to gain a deeper understanding of some of the driving forces behind the everyday life of bike-train commuters, which is often forgotten in traditional transport policy (Freudendal-Pedersen et al. 2010; Kvale 2007). Our aim was to discover the variety of different contextual elements influencing the bike-train commute and identify critical structures in the current transport system. The methods supplement each other by illuminating the travel pattern of the user group in different ways. Furthermore, the qualitative research provides independent knowledge about the practice of commuting (Cass & Faulconbridge 2014).

Table 2: Interview characteristics	
	Interviewees (no.)
Distance to work	
10-15 km	2
20 -25 km	4
25-30 km	1
35-40 km	4
45-50 km	2
Employment	
Master degree	7
Bachelor degree	1
Vocational education	4
Student	1
Size of household	
1 resident	2
2 residents	4
3 residents	4
4 residents	1
5 or more residents	3
Children in household	
None	5
Small child(ren) ages 0-5 years	3
Child(ren) ages 5-12 years	2
Teen(s) ages 13-20 years	4
Child(ren) outside the home	2
Age	
25-30 years old	6
31-40 years old	2
41-50 years old	3
51-65 years old	3
Gender	
Women	5
Men	9
Car ownership	
None	8
Car sharing member	1
1 car in household	5
Town size (place of residence)	
Around 5000 inhabitants	3
Around 30.000 inhabitants	2
Around 50.000 inhabitants	3
Around 600.000 inhabitants	6

Table 2 The characteristics of the 14 bike-train commuters (own production).

The interviewees where recruited through several different channels; from the passenger panel "Pendlerpulsen", through the webpage of the Cycle Superhighway Secretariat, and through our own network of acquaintances. The process is not meant to be representative as we sought to explore a variety of different practices in depth. To determine which societal structures that undermine the practice, the knowledge of when and why the bike-train commuter choose not to combine modes is crucial. This study therefore, includes daily, weekly and seasonal bike-train commuters to reveal the nuances in the practices. The strategy of our data collection was to interview enough respondents that new interviews no longer gave new insights (Creswell 2014). 14 interviews with bike-train commuters living in different locations in the Capital Region of Denmark were conducted, see table 2 for characteristics of the interviewees and map 2 of geographic spread.



Map 2 The departure and arrival stations of the 14 interviewees (own production).

The interviews were conducted face-to-face and covered five themes; 1) storytelling about the daily commute using pictures and symbols, 2) mapping of last week's activities to discover interrelated practices using a week schedule, 3) prior commuting patterns by asking to former habits 4) social constructed practices by asking to colleagues, friends and family, and 5) future mobility patterns by discussion different scenarios. The interviews lasted between 40 minutes and 1.30 hour and were all transcribed and analyzed according to occurring themes.

3.3 Limitations

Both questionnaires have been developed by separate institutions with different agendas and research purposes. The findings from the two surveys are therefore difficult to compare, but offer different angles to view the bike-train commute. The distribution of the questionnaires to specific groups of bike-train commuters in the capital region is a limitation of this study and the representative nature of the data for the user group as a whole will be discussed in the following section.

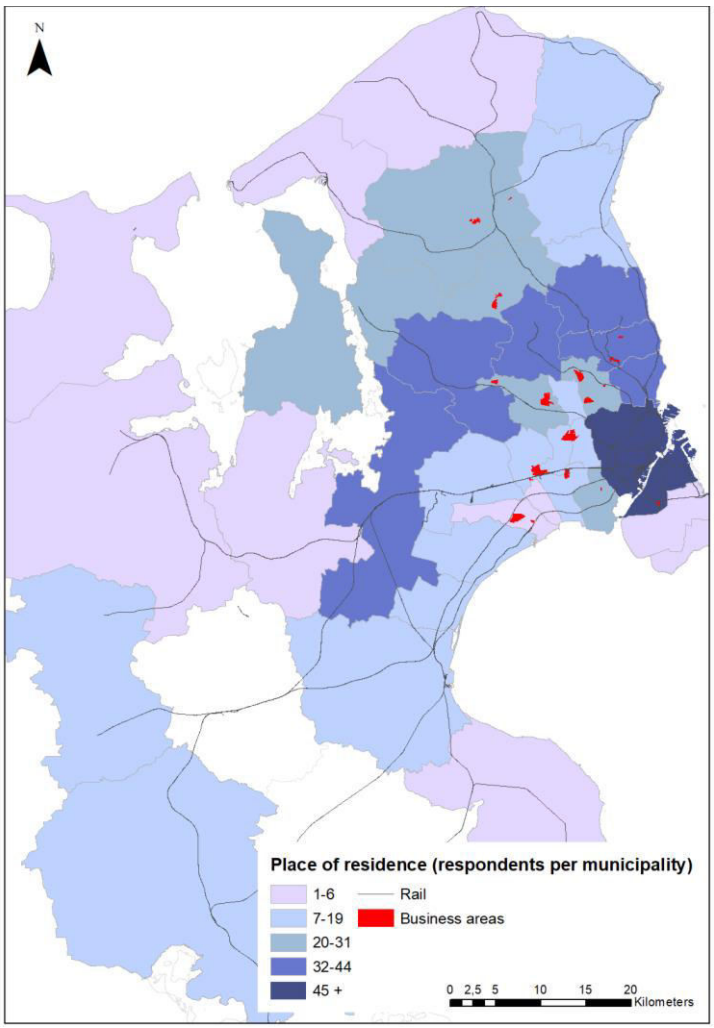
3.4 User Characteristics

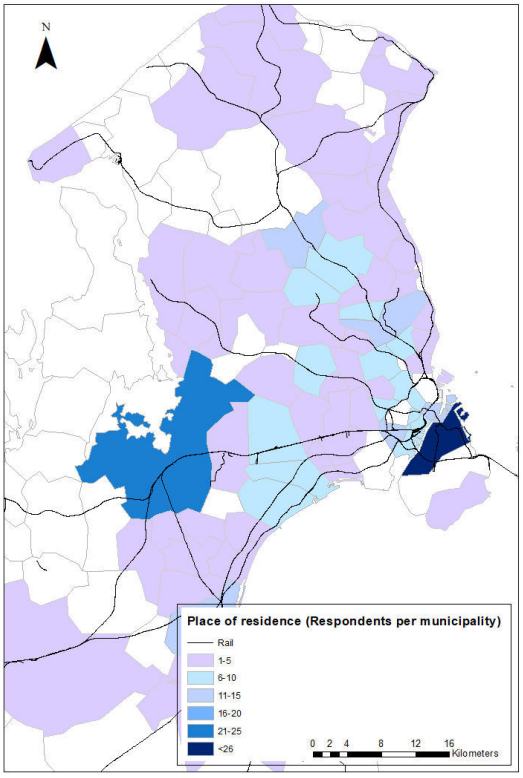
The characteristics of the bike-train commuters in the two data samples have been examined as part of uncovering the parallels between the two groups of respondents.

The participants of Gate 21's survey are highly educated, compared to the population of the region, see table 3. This might be an user characteristic of the intermodal traveler but it could also be attributed to the majority of knowledge companies represented in the survey, which by default have a workforce with an above average educational level. The most distinguishing difference between the two questionnaires is distance biked. In general, a majority of the commuters bike a relatively short distance (<10km) in their everyday commute. However, this group accounts for 82% of the participants of the CSS survey, as displayed in table 3, and 67% of the participants in the Gate 21 survey. Compared to an average commuting distance of 16.2 km in the Capital Region of Denmark the respondents in the two questionnaires travel significantly longer distances than the rest of the population in the same geographical setting, see table. The average commuting distance for the respondents of the Gate 21 survey is 26 km (based on n=570) while 72% of the respondents in the CSS survey have more than 15 km to work, see table 3. In this regard, both questionnaires show similar tendencies in comparison with the Capital Region, which imply that bike-train commuters are a distinct user group. Prior studies of bike-train users confirm some of the tendencies seen in table 3. The commuting distance to work and the norm of travelling short distances on bicycle is confirmed by Keijer & Rietveld (2000). It is difficult to determine if the questionnaires have captured the geographical variationsof bike-train users in the region, despite the geographical spread and representatives from the entire Capital Region in the two datasets, see map 3 and 4. The numerous differences between the two surveys might suggest that they have captured different segments of the group.

Table 3: The user characteristics of the participants in the two surveys and the general population of the Capital Region of Copenhagen			
	Capital Region of Denmark	**CSS (Passenger Panel questionnaire)**	**Gate 21 - Questionnaire**
Respondents		223	1328
Distance of commute (one way)	Average 16,2 km	72 % have 15< km	Average 26 km (N=570)
Distance biked on the commute	No data	Km a day <5km = 53 % 5-10km = 29 % 10-15km = 10 % 15-25km = 4 % >25km = 4 %	Km one way <5km = 67 % 5-10km = 23 % 10-15km = 7 % 15-25km = 2 % >25km = 1 % (N=570)
Days of intermodal travel	No data	1-2 days a week:12.4% 3-4 days a week:24.6% 5+ days a week: 63%	1-2 days a week:21.6% 3-4 days a week:34.3% 5+ days a week:44.1%
Gender distribution	Male:49%|Female: 50%	Male:45%|Female:55%	Male:51%|Female:49%
Education	Primary school:28% High school:10% Vocational education:32% Short higher education:5% Medium higher education:15% Long higher education:10%	No data	Primary school:4% High school:7% Vocational education:4% Short higher education:4% Medium higher education:25% Long higher education:56%
Gender and age distribution	Male Female >20 3.3% 3.3% 20-29 20.2% 21% 30-39 23.7% 23.3% 40-49 23.2% 22.3% 50-59 18.3% 18.3% 60+ 11.3% 11.8%	Male Female >20 0% 0.8% 20-29 8.9% 9.8% 30-39 10.9% 13.9% 40-49 21.,8% 23.8% 50-59 45.5% 32.8% 60+ 12.9% 18.9%	Male Female >20 1.2% 1.5% 20-29 17.7% 21.5% 30-39 32.1% 34.8% 40-49 25.2% 21.8% 50-59 15.6% 14.5% 60+ 8.2% 5.9%
Gender and distance biked distribution	No data	Two-way Male Female >5km 56.4% 50% 5-10 km 29.7% 28.7% 10-15 km 5.9% 13.1% 15-25km 4% 4.9% >25km 4% 3.3%	One-way Male Female >5km 37.5% 37% 5-10km 31.4% 29.5% 10-15km 19.2% 14.1% 15-25km 9.2% 13.8% >25km 2.7% 5.6%

Table 3 Comparison of socio demographics. (Danmarks Statistik n.d.; Danske regioner 2015) and the CSS survey (N=223) and Gate 21's transport survey (n=1.328) – own production.





Map 4 Municipality of residence for 223 respondents in the CSS survey – own production. (above)

Map 3 Municipality of residence for 1292 respondents in Gate 21's questionnaire. Red areas mark the participating businesses in the survey. The majority (55%) of the respondents live in the city of Copenhagen - own production. (left)

4. Elements of Bike-train Commuting Practices

We begin by identifying the elements of the bike-train user practices to gain insight into the societal structures that determine the travel patterns of this group of commuters.

4.1 Elements of Long and Short Bicycle Trips

The majority of the bike-train commuters have more than 15 km to work and the average travel distance is 26 km, see table 3. According to 53% of the respondents in the CSS questionnaire the main motivation for combining the bike with public transport modes is that *"it would be too hard to bike all the way"* and *"it is faster than to take the bike all the way"*.

> *"I have 21 km to work, it will take a little too long (to bike). It is almost an hour each direction. So, the combination is the only opportunity. I really want to bike, but.." (Bike-train commuter)*

The data indicate that other aspects than the traditional time optimizing rationality can motivate some of the bike-train commuters (CSS questionnaire). When commuting time is compared with travel distance, see figure 1, a tendency is found; the longer the commuters bike the more the overall travel time of their daily commute is prolonged.

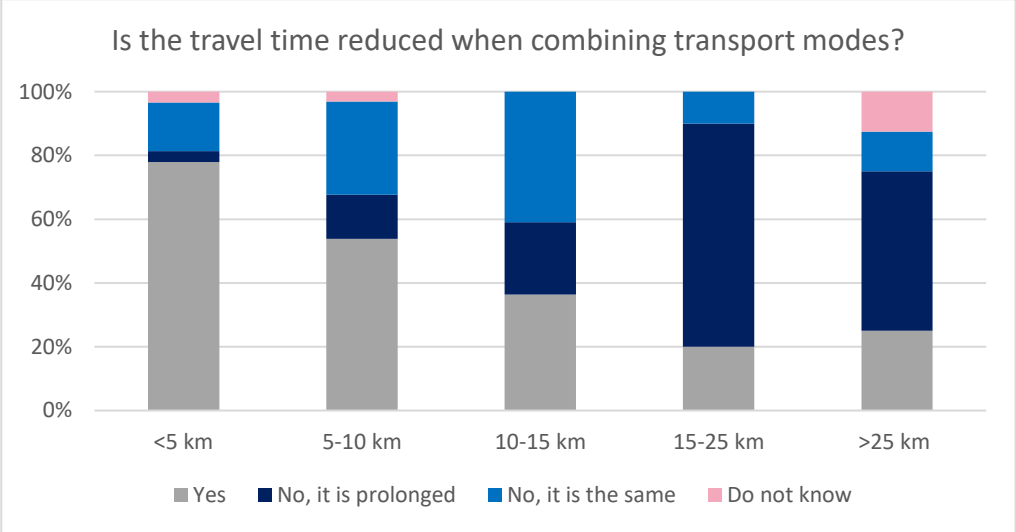


Figure 1 The difference in travel time. Own production - CSS questionnaire n=223.

Figure 1 indicates that the distance of 15 km a day might be divisive for the meanings associated with the commute. As we will later show, our findings suggest that long-distance bicyclists (more than 15 km per day) attribute their commute with other meanings such as exercise, health and mindfulness where the short-distance bicyclist (less than 15 km per day) among the bike-train commuters value more direct benefits of cycling such as flexibility and time optimization.

On average, the bicycle share of the commuting distance for the intermodal commuters is 23%, while the remaining 77% consists of different means of public transportation and walking, see figure 2.

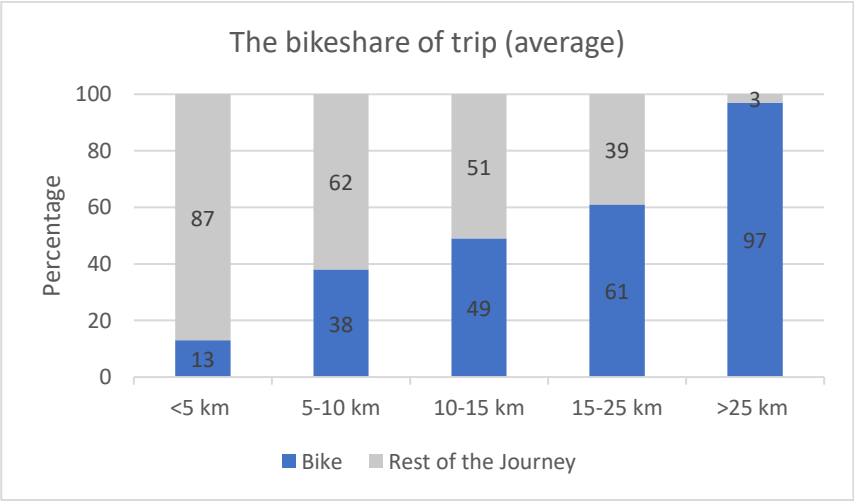


Figure 2 Average distribution of kilometers between the bicycle and public transport (%). Own production - Gate 21 questionnaire (n=570).

The most common way (75%) to combine modes seems to be biking part of the way in both directions to and from work and thereby covering first and/or last miles, while a minority (8%) bike the entire trip one way and travel with public transport in the other direction. Especially the bike-train users who bike more than 25 km per day choose to bike the entire way in one direction (CSS questionnaire).
The role of the bicycle is evidently different between the bike-train commuters, see figure 2, and the interviews indicate that at least two subgroups exist among the intermodal commuters. Figure 3 and 4 summarizes the differences in the elements of the commuting practice among the bike-train commuters who bike short distances, and the bike-train commuters who bike longer distances. The longer the respondents bike on the commute, the higher level of skills, e.g. planning for weather conditions or bicycle maintenance, and amount of bicycle equipment are required, see figure 4. The long-distance bike-train commuters associate their commute with exercise, fresh air, nature experiences whereas the public transport enables restitution, presentable work clothes, or more time with the family in the afternoon, see figure 4. The short-distance commuters mainly choose to bike because it is the most direct and fastest way to get to work and a way to avoid unreliable first and last mile public transport. The short-distance bike-train commuters rely on the stations bicycle parking to a higher degree and value the productive time they get in the train, see figure 3. The latter is a meaning often attributed with public transport (Cass & Faulconbridge 2015), however both groups describe getting "the best of both worlds" when they combine the bicycle and the train.

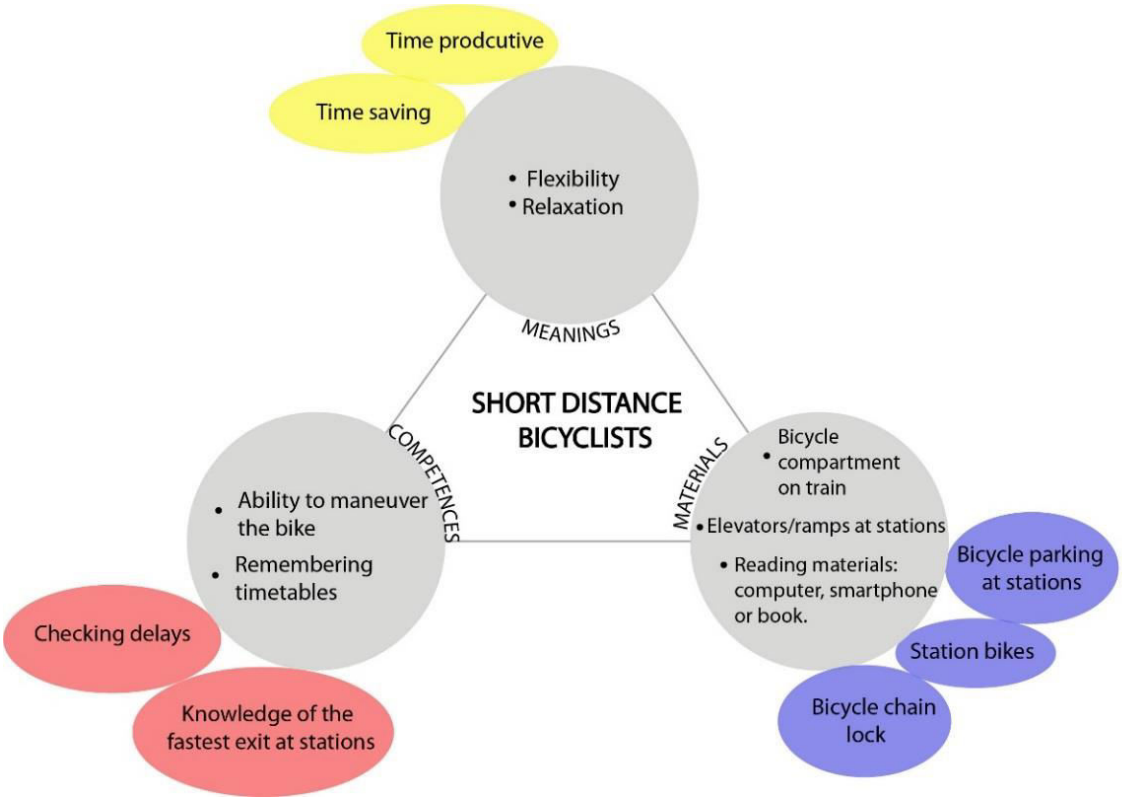


Figure 3 The identified elements among the bike-train commuters cycling short distances. The colored circles show the difference in elements between the two user groups of bike-train commuters, while the grey show similarities. (own production – based on interviews).

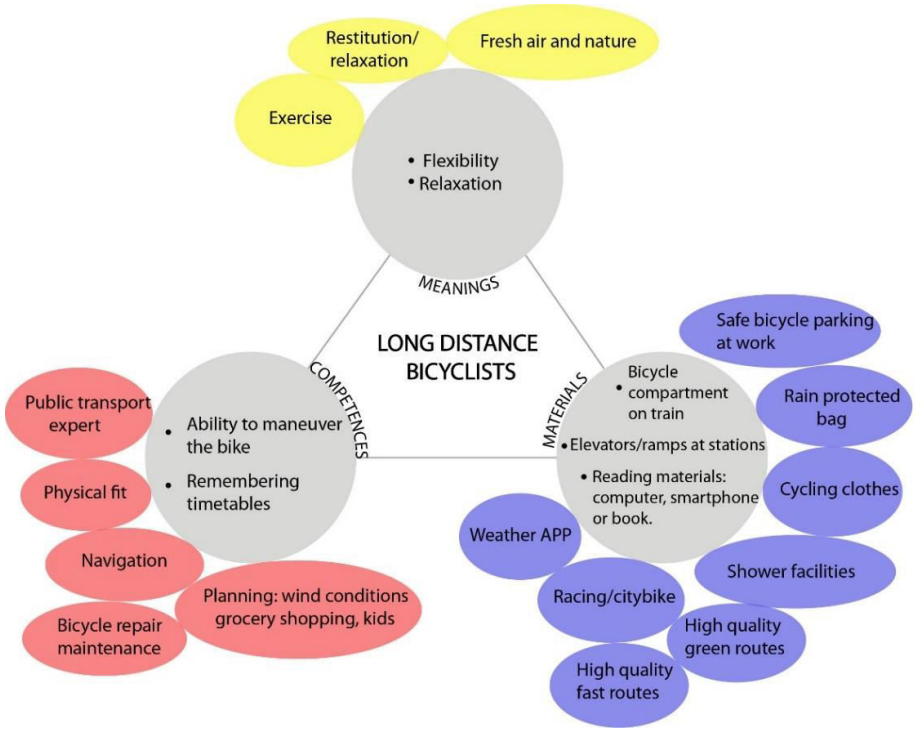


Figure 4 The identified elements among the bike-train commuters cycling short distances. The colored circles show the difference in elements between the two user groups of bike-train commuters, while the grey show similarities. (own production – based on interviews).

It requires special competences in planning when commuting longer distances on bicycle. Dressing according to weather, navigating routes, and thinking a couple of days ahead, requires overview and planning skills. The practice of long-distance bicycle commuting also requires different materials than a short-distance bicycle commute, see figure 3 and 4. The fact that long-distance bicycle commuting requires dedication in terms of planning and a variety of special materials are confirmed by several studies in the Netherlands and Denmark (Heinen et al. 2015; Hestbæk 2017). However, it is interesting that this type of long-distance bicycle commute is enabled by public transport. Being able to bring the bike on the train in one direction allow the long-distance bike-train commuters to cycle the entire way in the other. Bike-train combination thereby enables more than one type of commuting.

Overall, the data indicates that bike-train trips are attractive when the trip gets too long to bike and when it ensures a higher flexibility than travelling with public transport the entire trip, see figure 3. The interviewees highlight the feeling of flexibility and freedom that the bike provides, which is closely related to the overall experience of the public transportation as being unreliable. *"Often I experience waiting on the bus. I don't have to wait for the bike, so the bike reduces my waiting time, and that I really like."* (Bike-train commuter). When public transport is suffering from delays, bringing the bike on the train offers a sort of adaptability to unforeseen changes;

> *"I have many alternatives! If the regional train pisses me off, I can just bike the whole way. […] You don't want to stand and wait for 20 minutes and then get the messages that the train won't be coming after all, I can just cycle right away". (Bike-train commuter)*

The bike has the potential of reducing the waiting time of the public transportation, which is valued greatly by all bike-train commuters.

4.2 A Variety of Combinations

The bike-train system is highly complex, as there exist multiple ways of combining the bike with public transport modes in the capital region. In both questionnaires the train (S-train, local train and regional train) is by far the most used transport mode in combination with the bicycle, see figure 5.

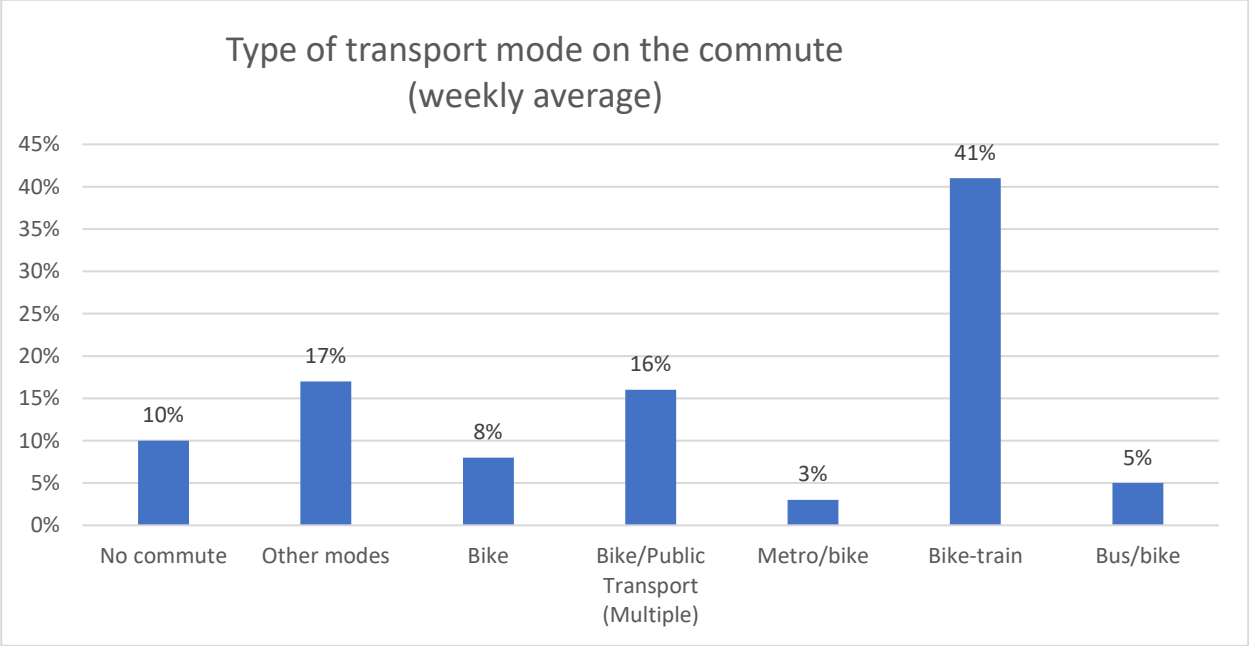


Figure 5 The bike-train combination is the most common among the respondents. In the category "other modes" the respondents either travel by car or by public transport. About half travel by car either as a passenger or in their own private car and the other half travel all the way by public transport. Own production - Gate 21 questionnaire (n = 1328).

The commuters use different means of transportation, different types of trains as well as different types of bikes. The interviewees have more than one bicycle; E-cargo bikes, regular cargo bikes, racing bikes, station bikes, which most often are a "havelåge" (slang for an very old and heavy bike, that you won't be sorry to lose), city bikes with or without child's seat (min. 7 gears - sporty), single speed bikes and shared bikes (such as Bycyklen and Donkey Republic).

The type of combination depends on the materials used in the commuting practice and vice versa. A station bike that is old, heavy and not very attractive to steal is often parked at the station close to the workplace or to the home. The cycling part of the commute is short when using this type of bike as the station bike is not ideal on longer distances. 8% of the respondents in the CSS survey bike the entire distance to or from work. This group is much more likely to use a bicycle that has characteristic of a racing bike, because they usually bike longer distances on a daily commute, and bring their bike with them on the train in the other direction. It takes different materials to make different combinations and the commuters have bikes for different purposes and different seasons. *"I have an electric cargo bicycle so I can pick up children"* (Bike-train commuter) or *"my station bike is a rubbish old bike"* (Bike-train commuter), *"when it gets cold and dirty outside, I usually use another bike, so the good one does not get damaged"* (Bike-train commuter).

The different materials in terms of the bike, enables the intermodal commuter to combine in different ways when traveling, but the different means of public transport; Metro, S-train, Intercity trains, Regional train and bus, also relates to different meanings and competences, see table 4 for example.

Table 4: Different transport technologies in a practice perspective			
Material	**Meanings**	**Competences**	**Enable**
Electric cargo bike	Comfortable, nature, environmental friendly	Comfort in all weather for kids and adult, planning skills to fit departure schedule and pick up hours	Bringing and picking up children on the way to or from work
Racing bike	Fast, exercise, community	Maintenance, ensuring comfort in all weather, good physical shape	Commuting long distances on bicycle
Intercity trains	Fast and comfortable work stations	Remembering timetables and specific departures	Productive time; working on your computer, relaxing, reading
Metro	Reliable, efficient, clean	Paying ticket fare	Avoiding congestion
S-train	Connectivity and flexibility	Negotiation and maneuvering skills with other commuters in train compartment	Bringing a bike
Bus	Uncomfortable, slow, unreliable	Knowing which you can bring your bike on	Trips outside of the train network

Table 4 Elements of practice associated with different transport technologies. (Own production – based on interviews).

The complexity of the transport patterns of the bike-train commuters is striking. Figure 6 illustrate the variety of mobility patterns among the interviewees, where not one intermodal trip is the same.

In general, the means of public transport are valued at their speed, e.g. few stops, frequency and reduced waiting time and their opportunity of productive time to relax or work. The transport modes with a high frequency enable the commuter to arrive at the station without checking with the departure schedule. We see that the interviewees often avoid the bus, as the bike substitutes the bus trip. The bus does not offer high speed and the general attitude towards the bus among the interviewees are that: "*...the bus arrives as the winds blows, you can't really count on it, whereas the train on the other hand arrives on time as promised.*" (Bike-train commuter)

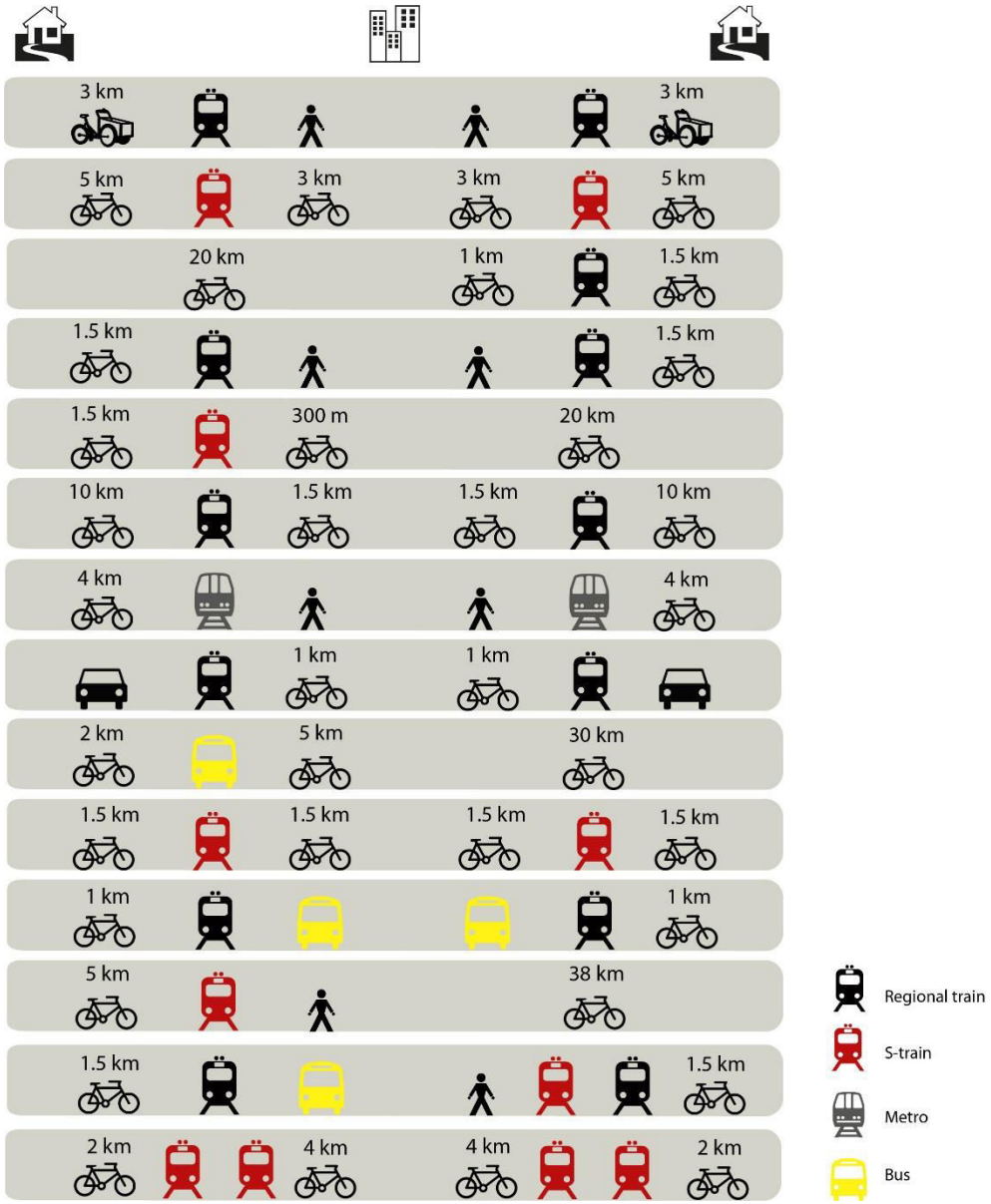


Figure 6 Compositions of the bike-train commute from home to job and back again based on the 14 interviews. The visualized intermodal trips are determined by seasons and daily obligation and might change. (Own production).

5. Interlocking Practices

Previous research indicate that the chosen mode of transport when commuting is closely related to other practices of everyday life. Daily social obligations have created complex commuting patterns where a series of activities are "squeezed" together and the commute need to facilitate the performance of other practices as well (Spurling et al. 2013; Cass & Faulconbridge 2015; Watson 2012). The complexity of the system and thereby the mobility practice of commuting is underlined by the fact that 31 % of the Danes have errands along the way to work (DTU 2014).

> *"Patterns of mobility, or private car use, might have nothing to do with transport policy at all, but be connected to how households are provisioned, where children go to school, how work and leisure are conducted, and so on."* (Spurling et al. 2013: 29)

Following this argument, it is interesting to uncover how some commuters are able to modify and make adjustments in their everyday practices in order for them to fit in the bike-train commute. Therefore, we look past the practice of commuting and explore the sequence of practices belonging to the bike-train users in their everyday life.

11.3% of the respondents have answered that their daily commute vary from day to day, which indicates the complexity of multimodal trips and imply that they depend on various factors (CSS questionnaire). The interviewees' commute and composition of modes, changes on a daily, weekly, or on a seasonal basis depending on their daily mood, weather, errands, or responsibilities such as picking up children. Their travel patterns reveal how the complexity of the daily life of individuals or families consist of interlocking practices that in some way or another affect the choices of transport mode. The following will investigate which unique spatial conditions or sequence of practices support the bike-train commute.

5.1 Family Life and Bike-Train Commuting

Numerus studies suggest that children's schedule and increasing number of daily activities are encouraging car based mobility patterns of their parents (Skinner 2004; Ziehler 2003; Cass & Faulconbridge 2015; Dowling 2000). According to Fotel (2004) the nature of children's mobility are both influenced by the spatial fabric of the neighborhood and by the mobility resources of the family. In this study we find that the bike-train commuters with children find themselves in the same dilemma regarding the sequence of practices in the daily life of their children. The interviewees with children all describe how difficult and challenging it sometimes can be to commute with bike and train while having the responsibility of picking up ones' children.

> *"[...]Once there was not enough time (to bike all the way home), and the weather was not good either, I needed to hurry home from work to pick up my children, and then there was a curfew (on the train) in the center of the city, so even though I had a bike ticket, I couldn't have the bike with me, but there was nothing to do about it, I did it anyway."* (Bike-train commuter)

Having to pick up their children after work affect how far the interviewees choose to bike or if they choose to combine modes at all. The interviewees only bike further distances on the few days a week when they do not have to pick up or bring their children to school or kindergarten. The many obligations of everyday life demand a fast and reliable commute as the bike-train user have to get home, pick up their children, make dinner and so on. The prolonged time biking or delays on the train reduce the time the interviewees can spend with their family. The data indicate that those who combine bike-train everyday are the users who bike short distances (<5 km a day) while the group who bike 5-20 km a day make intermodal trips less frequently in a week. The respondents who bike longer distances point at time as the main parameter that can keep them from biking some days (CSS questionnaire).

> *"I have considered it (biking one way) very shortly, but the problem is the time factor, it will take too long. I will lose some hours of work that I have to catch up at another time. Riding the bike on this distance, it might take 1.5 hours and then I'll have to get a shower and get ready and then I'll have to take the same trip back and to pick up children, so it's almost impossible to do it."* (Bike-train commuter)

The way the practice of commuting interlock with the daily responsibility of parenthood is difficult to change. The interviewees rely on their partners taking that responsibility when they combine modes. Many of them therefore have very complex weekly timetables and calendars to coordinate bike-train combinations, see table 5.

	MONDAY	TUESDAY	WEDENSDAY	THURSDAY	FRIDAY
07	Bike (20 km)	Car (2 km) Drop off children at school Car (20 km)	Work from home Car to bring and pick up children (2 km)	Car (2 km) Drop off children at school Place the car at station* Train Walk (1 km)	Bike (1.5 km) Train Walk (1 km)
09	Work	Work		Work	Work
16	Bike (1 km) Train Bike (1.2 km)	Car to pick up children at school			
17	**Meeting at school**	**Children's sport and activities**		Walk (1.5 km) Train Bus	Walk (1.5km) Train Bike (1.5 km)
	Bike (2 km)	Car (2 km)			
19	Home	Home		Home	Home

*Table 5 Calendar of one of the bike-train interviewees – own production. The week schedule is not representative for the bike-train commuters but illustrate the complexity of modern commuting patterns. * (Husband pick up the children and take the parked car at the station)*

As the schedule shows the bike-train commuters with kids need a high level of competencies to be able to organize and plan their everyday life in order to make the bike-train combination possible, see table 5. In the case above the three children of 4, 8 and 10 years rely on their parents driving them by car to school or sport activities in the afternoon. This limits the number of days that their parents choose to commute with bike-train. Compared with the two other families among the interviewees the children either bike along with their parents to school or is transported in a cargo bike enabling bike-train commuting every day of the week. The distance and placement of the school, unsafe bicycle routes, bicycle skills of the children and available transport options such as a cargo bike, car or children's bicycle all affect the practice of bike-train commuting.

5.2 Temporal Pressure

Former research argues that the temporal pressures of the high sequence of daily obligations and the spatial fragmentation of services, workplace and residence make it difficult to compete with the automobile for sustainable transport modes (Cass & Faulconbridge 2015; Urry 2004; Dennis & Urry 2009; Næss 2012). Despite the representation of suburban residences among the interviewees, only a few of the interviewees express a need of having a car available to handle the numerous tasks of everyday life. Only one third of the interviewees own a car and no household have more than one. The need of a car is mainly expressed as an outcome of practices involving the mobility of children or shopping errands. One of the interviewees drive in her car to the station, board the train and bike on to work when she arrives at her designated station. The car is a part of her daily commute as; *"I use the car because I want the opportunity to go grocery shopping on the way home. If I bike to the station or take the bus then I would never go shopping on the way home. I would have to walk 500 meters carrying all those bags to get home. No – I'm too old for that"* (Bike-train commuter). This opinion is expressed by a few of the interviewees living in more sprawled areas where the shopping is handled by car and sometimes on the way home to avoid going back and forth from the residence. However, the majority handle their daily shopping on foot or on bike on the way home from work. A tendency is that several of the interviewees get groceries delivered to their home and order online instead of going to the store themselves. They thereby change the spatial obligation of the practice of shopping and make their commute by bike-train easier.

Among other interlocking practices socializing can affect the bike-train commuters chosen mode of transport. The choice of commuting mode might change if the interviewees have social plans after work. For some the bicycle can be troublesome to bring with you to a social engagement, for others the bike-train commute enable a flexible and convenient way of cycling directly to the social obligation. It all depends on the nature of the socializing and the acquaintances the interviewees are meeting. In general, the acquaintances of the interviewees seem to be using their bicycle and public transport to the same extent as the bike-train commuter; making it the obvious choice when continuing to a social activity after work:

> *"Most people in Copenhagen are cycling, it is completely ridiculous to do anything else [...] I have a friend from Fünen who always takes the bus and it is very annoying. Take the bike for Christ sake, you have been living here (in Copenhagen) for 7 years!"* (Bike-train commuter).

The urban density of the Capital Region of Denmark seems to support the mode of bike-train travelling as few of the interviewees need a car to manage their daily obligations. The way commuting interlock with other practices can however require special materials such as a cargo bike to drop off or pick up children on the way from the station or a reconfiguration of how practices interlock as getting grocery delivered instead of going to the store. The specific time schedule of the different activities of the day, especially concerning commuters with children, requires special competencies in terms of planning the daily life.

6. Changing Practices

Methods of changing and reconfiguring practices is still an unexplored field. Practice theory is often criticized of only being able to describe current consumer behavior, without offering any solutions of how practices are transformed into more sustainable consumption and integrated in policies (Strengers & Maller 2015) However, in 2013 Spurling et al. suggested different approaches of changing practices through a new framing of policy. The transition of practices can consist of different incremental or more radical changes of elements, meanings and skills. Inspired by Kuijer (2014), and her practice-oriented design approach, the following will examine how tensions in the current practice of the bike-train user can be used to inspire new practices or reproduce bike-train practices. The policy implications of the findings will be discussed in relation to promoting bike-train practices on a larger scale.

6.1 Maintaining Practices

We claim that maintaining a sustainable practice can be just as important as trying to recraft an unsustainable one. Unfortunately, only half (54%) of the bike-train commuters are satisfied or very satisfied with their commute to work, while 23 % is dissatisfied or very dissatisfied. This tendency is similar among commuters who only use public transport, while commuters who only commute by bike in general are more satisfied with their commute (73%), see figure 7.

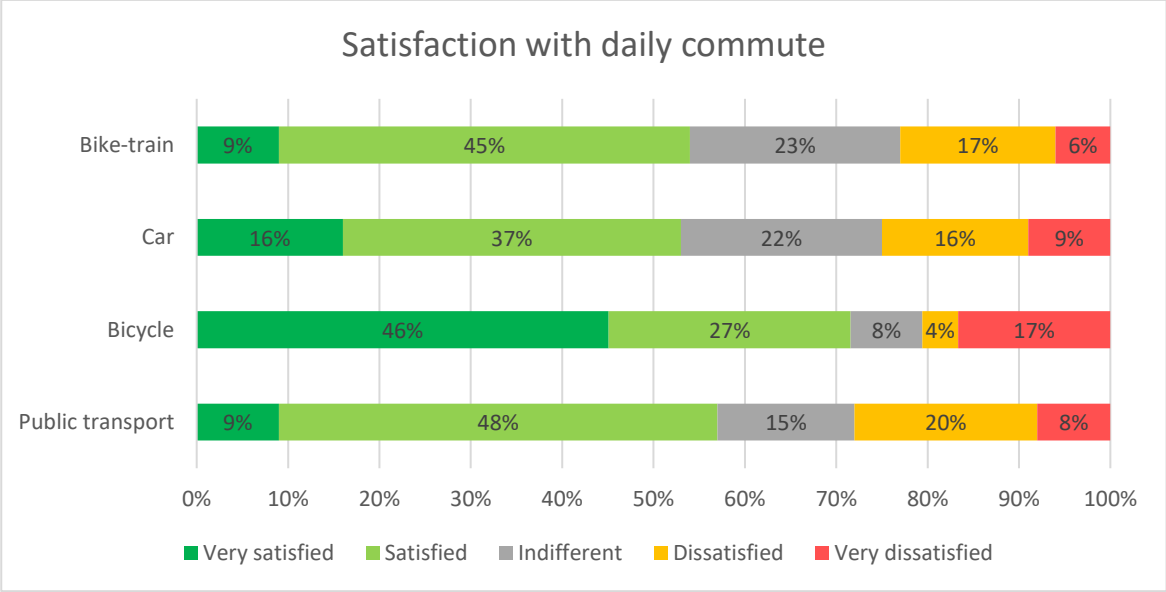


Figure 7 Satisfaction with the daily trip to work among different type of commuters in Gate 21's data. Based on 8 of the largest companies (n=4706 out of the 15794 respondents) in "Moving People". (Own production).

The dissatisfaction among the bike-train commuters might be attributed to the ambiguity of public transport. If the bike-train commuter is to keep reproducing the practice the three elements of the practice needs to be consistent. However, our interviews suggest that the

speed of the train and the relaxation that this transport mode offer is challenged in peak hours and when departures are cancelled.

> *"You can't be sure that you have time for complementation and relaxation when the trains are full [...] why should you then not just choose the car and rid yourself of a lot of annoying morning commuters?" (Bike-train commuter)*

Half of the interviewees are considering buying a car and thereby changing their daily commute. *"It's mainly the days where I get angry at public transport, when a train is cancelled, that I consider buying a car."* (Bike-train commuter)

The flexibility and speed that the bike-train mode offer as an alternative to a trip entirely made up of public transport or cycling seems to be key to maintain the practice. 48 % answer that the flexibility of the bike-train mode is their favorite part of their journey and 17 % answer that it is the possibility of getting faster from a to b (CSS questionnaire). Tension arises in this practice when train compartments are overcrowded or trains are delayed.

The majority of the interviewees travel to stations with many departures and several modes of public transport. This creates a more flexible journey, since they do not have to rely on shifting between public transport modes, time their bike trip with a departure schedule or risk waiting a long time, as they have more possibilities if a train is cancelled.

> *"The station I bike to have much better train connections than my nearest station, so I experience a much higher flexibility on the days when public transport is a mess."* (Bike-train commuter)

Travelling to stations with many departures gives the interviewees a sense of freedom as the flow of their journey is not interrupted. These stations maintain the feeling of flexibility and freedom that individual transport modes such as the bike provides. At these stations the interviewees do not have to check departure times from home, as the wait at the station is less than 10 minutes.

> *"Two things matter: the first is that I can travel with the metro 98% of the time, there is never a problem, it's always running. The second is that I don't have to wait for it, that is what matters to me."* (Bike-train commuter)

There is a willingness to bike a longer distance to get to a better-connected station among the interviewees, especially among the bike-train users who attribute the bike ride with exercise.

> *"The station I travel to when I bike a longer distance is much better connected. It gives me way more flexibility when I am travelling. I never have to wait more than 5 minutes and I don't have to time my departure at work or at home." (CSS survey, response)*

41 % of the 15.794 participants in Gate 21's transport survey reply that better options to shift between modes can encourage them to use public transport more. This seems to imply that stations with good coverage and many connections is not just important to support bike-train commuting, but for users of public transport in general.

Waiting Time Value

Some of the key elements in maintaining the practice of bike-train commuting seems to be; reduced waiting time, reliable train service and productive transport time. Connectivity and a high frequency of trains enhance the freedom of combining bike with public transport. Current tensions in the practice arise when public transport is unreliable or overcrowded; the favorite part of the journey is the time spend in the train, but it can also be the worst part. The time the bike-train commuter spend in the train is seen as productive and meaningful time. Following this argument, there is a considerable potential in making the experience of the commute more pleasant and acceptable if these positive feelings of the commute also is present in situations of delays. The frustration that the bike-train commuters expresses when experiencing delays in the public transport is notable among the interviewees. In order to maintain the bike-train practice and prevent the bike-train users to adopt more unsustainable commuting patterns, it is among other things necessary to raise the waiting time value, which we have shown to have an influence on the overall commute. This would require material interventions in waiting areas at stations that could ensure a valuable waiting time, when the bike-train users are experiencing delays. The concept of waiting time value is not a particularity new idea, it has been an element in planning of public transport for decades (Friman 2010). However, to our knowledge the consideration of waiting time value is new in relation to bike-train trips, as the waiting time is of a shorter period. Inspired by the waiting time value in airports and the statements from our interviewees, we suggest the following improvements;

- Upgrade of the station environment to include zones of lounging and working; materials such as wifi, a power outlet, tables would be required.
- Access to entertaining services while waiting; such as a commuter bookshelve, free download of e-books, variance of newspapers.
- Access to last mile services such as free-floating car sharing or station bikes if trains are delayed.

Capacity Issues

We have identified issues with the capacity both in regard to finding a place to sit in the train and finding a place for the bike on the train during peak hours. Both things cause conflicts and poses a potential threat to maintaining the bike-train practice. The latter might be addressed by a fully expanded network of station bikes reducing the number of bicycles being brought unto the train. While the general capacity issues in peak hours might be relieved by a new ticket structure for commuters offering discounts outside of peak hours. However, future interventions should not only focus on changing the materials of the practice, but also to look beyond it, and pay attention to the sequence of practices that creates these capacity problems. Five of the interviewees manage to avoid the frustration of overcrowded trains by either leaving home earlier, biking to another station or having more freedom and flexibility to work at odd hours. An intervention in the existing ticket structures could encourage bringing the bicycle on the train outside of peak hours, but only if it is supported by flextime on the workplace. We suggest the following improvements to address the capacity issues and maintain the comfort of bike-train commuting;

- Discount on commuter pass used outside of peak hours
- Bike-share system with a variety of different bicycles reflecting the need of the user group
- Re-design and expansion of bicycle compartments on trains

6.2 Recrafting Practices

The empirical base of this study suggest that the bike-train mode mainly consists of short-distance trips. More than half of the bike-train users' bike less than 5 km per day on their intermodal commute, while 67% of the respondents in Gate 21's survey bike less than 5 km on their bike-train trip to work (Gate 21 questionnaire). The flexibility and connectivity in combining modes are some of the main motivational factors for bike-train commuters. The catchment areas of stations are spatially increased eight times when the bike is used as a feeder mode compared to walking (Trafikstyrelsen 2009). The bike-train trip could achieve a larger degree of flexibility and connectivity if the users chose to bike further than they currently do. Only 9% of the respondents answer that nothing can motivate them to bike further on their commute, see figure 8. Especially exercise and the possibility to get more flexibility on the bike-train trip are motivating factors. The interviewees who do not associate the bike with exercise, but see it as a transport mode, are only tempted to bike further if they can save time on their trip by catching a faster train. Despite the interest to bike more on the daily trip to work, the interviews imply that many barriers have to be overcome for it to happen.

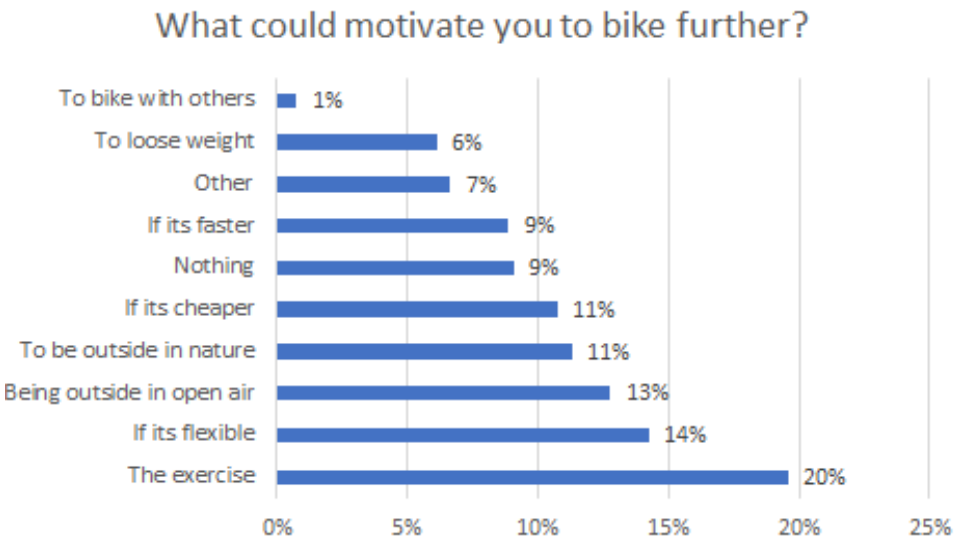


Figure 8 Respondents in CSS questionnaire, multiple answers – own production. (541 responses, 223 respondents)

The interviewees who have managed to bike a longer distance on their daily commute have to some extent had to change how their daily practices interlock. Practices involving showering, grocery shopping or picking up ones' children can all stand in the way of cycling more often or further. Shower facilities and locker space for toiletries at the workplace are for instance

important elements in the practice of the interviewees who bike more than 10 kilometers. 33% of the respondents in Gate 21's questionnaire agree that improved shower facilities at their workplace could motivate to bike more often and longer distances.

Many of the respondents in the interviews started combining bike with train as the distance to work became too long after moving or getting a new job. Some of them bike one way and combine with the train the other way. This is due to the extended distance seeming overwhelming, since it requires more time spend on the bicycle. Lack of physical prowess to take on the extended distance also play a significant role. When asked if they could bike further on their commute, the interviewees refer to barriers such as the price of new equipment, e.g. racing bike or biking clothes to increase speed, and the meaning associated with these materials.

> *"Sometimes I consider buying a racing bike, but I don't know, because I refuse to wear that outfit (lycra) so I might already be a hopeless case."* (Bike-train commuter)

Among the interviewees who bike longer distances, only a couple of the men own a racing bike and lycra clothes. The rest explain how they easily make the journey in regular sports clothes and on their city bikes.

> *"At some point I got tired of hearing myself complain that I needed a racing bike. I decided to just try it (biking to work) without one. And I ended up being really happy with my regular bike. It works just fine. [...] There is a mental barrier for the people who wants to bike longer you think "pheew can I really do that?", the prolonged travel time, the equipment and the logistic challenges can be a barrier."* (Bike-train commuter)

The interviews suggest that if biking further is to become an embodied practice, each user have to challenge themselves and go beyond the distance they normally bike. New skills, meanings and possibly materials are required to bike longer distances. For instance, just discovering and navigating on new and interesting bicycle routes can be a challenge for some of the interviewees, who are not familiar with the local area when they move or get a new job. According to Gate 21's questionnaire, 44% state that they would bike more on their commute if the bicycle routes to their workplace where better. Only 6 % disagree with the statement. Another way to affect and recraft practices is through material interventions in construction of infrastructure. If the infrastructure provides a competitive alternative to the car commuting practice, it might be a persuasive element to try something else i.e. the bike-train practice. New and improved bicycle routes have proven to raise the share of bicyclists and the distance people are willing to bike significantly (Vedel et al. 2017). Our interviews indicate that knowledge of current routes in particular seems to be missing.

The bike-train users who bike further than the average commuter explains that they exchange knowledge of routes, combination options and sometimes even bike together with their colleagues or acquaintances. When made aware that others can bike the distance, it does not seem as impossible as before.

"One of my colleagues began to bike because I did it. In the end I think it's like: "if you can do, then I probably can". (Bike-train commuter)

The bike-train commuting practice require a number of planning and scheduling competences. The interviews indicate that these skills are often developed in social settings such as the workplace, friends and family. According to Kuijer (2014) testing of new practices can make the participants aware of their former actions in their old practice and enable a change in elements afterwards, which, when applied to the bike-train practice could prove useful. A Swedish study shows that test-projects where people borrow specific bikes and equipment and get information about routes can enhance the distance people bike (Strömberg et al. 2016). One example of testing new practices is described by Strömberg et al. (2016) in "Trying on change - Trialability as a change moderator for sustainable travel behavior". Here, car drivers tested an e-bike in a trial period. During this period, they had consultants helping them (competences) as well as access to different equipment for the bike (materials). However, they had to figure out how they would include the bike in their everyday live by themselves. In the case of the project "Testcyklisterna" the participants all chose to bike afterwards as the test showed them that they could manage to bike in the everyday live. (Strömberg et al. 2016). This example shows that the embodiment of a practice through a trial period can be a very effective way to recraft practices, which can also be applied to the bike-train practice. Testing of new bicycles and a bike-train navigating app might encourage more commuters to buy a bicycle apt for longer distances. Counseling and advice to how other interlocking practices of everyday life can fit together with longer bike-train trips also seems imperative. The following elements could be a part of a bike-train trialability project with the purpose of increasing the distance biked on the commute;

- Bike-train sponsor at the work place
- Mobility counsel at work place
- Test periods with different types of bicycles
- An intermodal navigation tool to discover new routes to work
- Health test offered with commuter pass or in connection with a campaign at the work place

6.3 Substituting Practices

Even though 87 % of the citizens in the Capital Region of Denmark live and work no more than 2 km from a train station, bike-train combinations only represent 2.3 % of the share of all trips in 2014 (Transportministeriet n.d.; Region Hovedstaden 2014). To substitute unsustainable commuting practices the bike-train mode needs to be a competitive alternative facilitating similar needs of the commuter when performed (Spurling et al. 2013). It applies to all of the interviewees that transformative events such as getting a new job or moving inspired a change in their mobility practice. The distance, amount of congestion or new transport options meant that their former way of commuting no longer was the most

attractive. All of the interviewees commuted by bike or car, before substituting to a bike-train commute.

The majority of the former cyclist commuters among the interviewees chose to combine modes as the distance between their workplace and residence increased; *"I started to combine modes when we moved outside the city, to more nature and a better school, because the distance to work got longer"* (Bike-train commuter). The general tendency among the interviewees is that the practice of commuting by bicycle is not able to compete with the bike-train mode on longer distances. The fact that the former cyclist chose the bike-train mode and not the car, which is a dominant mode on such distances, is due to numerous factors. What seems to be key, is an infrastructure that invokes the feeling of the bike-train commute as being "the obvious choice". Based on the interviews in our study it is possible to set up a series of elements of the bike-train practice that is to be supported and prioritized in order to substitute unsustainable mobility patterns with bike-train commuting practices. The listed elements embody a variety of both intrinsic and extrinsic elements and describe a preferable scenario of bike-train commuting:

- a guaranteed spot to sit on the train
- room for your bike on the train
- direct trains so you avoid shifts
- many departures with a high frequency
- fast trains operate
- access and egress routes enable a continues flow to and from the station
- bicycle routes to and from the station provide experiences, safety and flow
- transport time is valuable
- bicycle parking is of high quality
- services allowing bicycle repair, bike sharing etc.

All elements support the bike-train trips and it might be considered to make these improvements at well-connected stations as the bike-train users favorize them. A well-connected station might imply several things; it can be a station well connected to the public transport system, but it can also be a station with special services for bike-train commuters. According to Puello & Geurs (2015) a strong link exists between perceived connectivity of a station and the quality of the station. Thus, having ''attractive stations'' are important for the commuters who arrive to the station by bike. High-quality bicycle parking is especially important as it enhances the perception of connectivity (Puello & Geurs 2015). Furthermore, Krygsman et al. (2004) argues that elements that slow the trip to the station down, i.e. congestion, traffic lights, parking a bicycle, queues at the ticket machines all play a major role in the connectivity of the station. Access and egress conditions, can have a significant effect on how long intermodal travelers bike and thereby influence the size of the catchment area of a station.

Among the interviewees two of the respondents are former car commuters. When they choose to bike instead of the taking the car or public transport some of the way, it is because of the possibility of exercise and saving time.

> *"My weight is too high, so it usually helps biking a little (instead of taking the car to the station) during the spring. I can lose 1-5 kg".* (Bike-train commuter - 56 years old, 4 km to the station)

> *"The bike is primarily a mean of transportation, but I have problems with my knees and if I'm in pain, then a couple of km on the bike helps. I wouldn't call it exercise more "maintenance".* (Bike-train commuter - 50 years old, 1-2 km biked)

The interviews suggest that the physical activity achieved on even short bike trips to and from the station can be a motivational factor in choosing to combine modes. Furthermore, 25 % of the respondents in the CCS questionnaire, who do not bike as a part of their commute, answer that they consider biking because of the possibility of exercise (CSS questionnaire). However, the two former car commuters among the interviewees profess that they would prefer to drive all the way to work if they could. Both have been used to driving to work in their car, but have both been "forced" to do something else as congestion and parking fees have increased in Copenhagen. Public transport has therefore become a more feasible and faster alternative to go to work than their car. In general, the interviewees commuting to Copenhagen describe how public transport is able to compete with the car, because of the speed and the ability to skip the congested roads.

> *"I would pick the bike-metro combination any day of the week. It is simply impossible to compete with the metro when you are traveling to downtown Copenhagen time- and comfort wise compared to the car. It is the obvious choice."* (Bike-train commuter)

Our finding suggests that the substitution of practices such as replacing the car commute with the bike-train mode, not only require good bicycle infrastructure and a highly developed public transport system, but also restrictions of automobile privileges in urban areas. As an example, the removal of the free parking spaces at the worksite, has proven to be a crucial intervention in substituting the practice of commuting by car according to Buehler & Hamre (2014b). The regulation of automobile privileges will likely determine the effectiveness of the promoting of a more sustainable mode. Crucially, the policies targeted to substitute the current unsustainable practice of driving the car must consist of several interventions; promotion of the health benefits of combining bike-train, prioritizing the bike-train mode, both on the bike lanes and at stations, to discouraging tactics such as regulations on car parking, congestion zones and higher vehicle registration fee and so on.

6.4 Changing Interlocking Practices

It is clear that the bike-train commuters have a complex everyday life, and that it is demanding to balance the bike-train practice while grocery shopping, picking up children and attending social obligations. Many of these practices are controlled by strict societal timetables, i.e. kindergarten opening hours, social obligations, having to plan according to work schedule. These can be categorized as temporal pressures as they dictate how many practices interlock in today's society (Cass & Faulconbridge 2015). It can be especially hard to juggle for the bike-train commuters since their commuting is already complicated. To reduce or overcome this barrier, viable alternatives to the interlocking practices of everyday life, must be presented.
The practice of picking up and dropping off children is currently rather inflexible as only 0,5% of all daycare centers are open after 6 pm (Projekt Børnepasning 2013). This issue is trickling down and affecting other practices such as commuting, and it is a stress factor for many families with young children.

> *"Daycare facilities are a prerequisite for a labor market where both parents can have a job. The current daycare opening hours are a barrier and a stress factor for many families"* – Helle Holt, Senior researcher at the national research center for welfare (Pedersen 2013)

Some daycare centers in Copenhagen are beginning to experiment with extended- and even 24 hour opening time (Copenhagen Municipality 2015). If it becomes more common that day care centers begin to offer extended opening hours, it will reduce the temporal pressure of the interlocking practices for the bike-train commuters with small children, thus making their day-to-day life easier. The effects of more flexible day care options could be further strengthened if flexible work schedules become more widespread (Holm-Petersen 2012). However, flexible work schedules will not only benefit families with small children, but all current and potential bike-train commuters and maybe even the transport system as a whole. The interviewees describe how flexible work schedules have enabled their bike-train practice to a large degree. Some of the long-distance commuters even describe that they would never have adopted the bike-train practice, if it was not for the flexible schedules, and that biking is accepted and encouraged by their employer.

> *"I feel proud when I arrive at work with my bicycle. My colleagues say: wow you biked today? Good job! When I arrive late and I have been biking it is also a little more acceptable to my boss." (Bike-train commuter)*

This attitude of encouragement towards the bike-train mode (and biking in general) and the option of having a flexible work schedule, is very beneficial for the mode, as it creates flexibility in how other practices can connect with the commuting practice. It should be noted, however, that not all professional groups can adopt flexible working schedules due to the nature of their work. The effect of a more widespread acceptance of flexible work schedules would also benefit the transport system, as peak loads would be decreased and spread out to some degree (Saleh & Farrell 2005).

Grocery shopping is another practice that interlock with the commuting practice and can be difficult to fit in for the bike-train commuters. As stated earlier, some of them chose to have their groceries delivered to their home address to reduce the temporal pressure of everyday life. It could be suggested that this particular competence would be beneficial to share with other bike-train commuters. Overall, several different initiatives concerning different sectors of society could change how bike-train commuting interlock with other obligations of everyday life;

- Flex time offered at the workplace
- Bicycle campaign creating a bicycle friendly environment at the workplace
- Discount on delivery services offered together with a commuter pass
- 24-hour daycare
- Bicycle driver's license mandatory in school
- Mandate child friendly routes to schools and leisure activities
- Mandate retail space by stations

7. Policy Implications and Conclusion

Derived from a practice perspective the main insight of this study is the existence of different types of bike-train users. The combination of bicycle and public transport in the Capital Region of Denmark enable a variety of commuting practices. Despite the similarities in meanings, materials and skills bike-train commuters share with other groups of bicyclists, and public transport commuters our research suggest that the combination of bicycle and train produces unique mobility practices of its own. The mobility practices of the users are interlinked with different materials (such as a station bike or bicycle compartment in the train), competences (such as navigating the public transport network by bicycle), and meanings (such as restitution, flexibility). We have additionally identified a bike-train commuter group not previously describe in the literature. Even though Kager et al. (2016) describe a potential of expanding the catchment area of a station resulting in bike-train commuters cycling more than 4 km to the station the bike-train commute has not been prescribed cycling patterns of more than 15 km a day (Kager et al. 2016; Krygsman & Dijst 2001; Keijer & Rietveld 2000). Our study suggests that the possibility to bring the bicycle on the train in the Capital Region of Denmark allow commuters to cycle the entire way to work in one direction and restitute on the train in the other direction thereby expanding the distances often attributed with bike-train commute. Our findings indicate a difference in the mobility practice of the bike-train commuters who cycle long distances (>15 km a day) and the ones that cycle shorter distances. We have showed that the mobility practice of these two user groups vary in term of materials, competences and meanings. In our data sample the majority cycle short distances (0-5 km) to and from the station, while the bike-train commuters cycling more than 15 km a day make up the minority.

We have identified several tensions in the commuting practice of bike-train commuters, see figure 9. Based on the identified tensions in the current practice of the bike-train commuters we suggest several different policies of a more or less radical nature. Figure 10 illustrates different measures aimed to recraft or maintain current bike-train practices, to change how practices interlock or to substitute carbon-based practices.

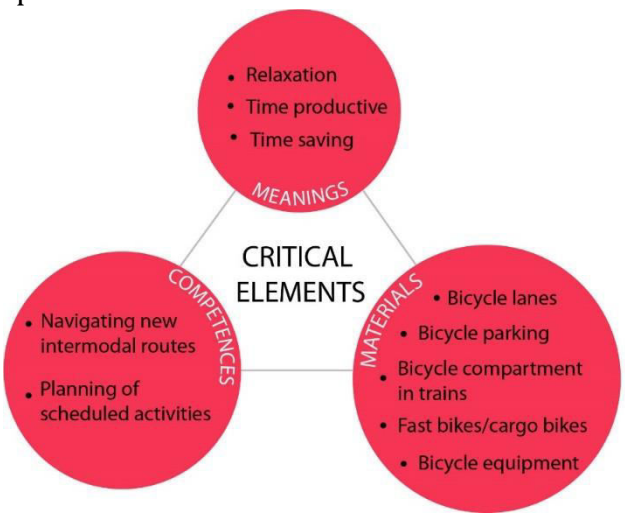


Figure 9 illustrate the identified tensions in the commuting practice of bike-train users. The elements visualized in the figure are all pressured by societal structures and needs to be addressed to maintain and upscale the practice. (Own production)

COMPETENCES			Bike-train mentor to increase skills
Bicycle repair workshops to increase skills	Travel app - for navigating and planning routes	Mobility counseling at work	Test projects of different station bikes to embody the practice
MATERIALS	Build bicycle parking for different types of bikes	Invest in trains with flexible capacity for bringing the bicycle	National station bike network with a variety of bicycles
Prioritize investments in bicycle infrastructure connecting to station areas	Investments in stations to improve waiting time value	Investment in different types of bicycle infrastructure e.g. green and fast routes	Improvements to public transport to guarantee relaxation and productivity
MEANINGS			Restrictions of automobile privileges to discourage car use
Bike to work campaigns to create a bicycle culture	Health tests offered with commuter pass and through test projects	Bike-train commuter services at station to improve waiting time and bicycle commute	Improved ticket structure to encourage travel outside of peak hours
INTEROCKING PRACTICES		Flex time at workplace to enable bike-train commute	Flexible opening hours in kindergarden
Bicycle "drivers license" in schools			
Bicycle service at station/work	Discounts for delivery services offered with commuter pass	Mandate child friendly bicycle routes to education and recreational sites	Demand shopping areas at public transport nodes
Showers at work to enable long distance			
INCREMENTAL CHANGE			RADICAL CHANGE

Figure 10 summarize potential policy interventions discussed in prior sections and are inspired by the current elements and tensions in the mobility practices of bike-train commuters. (Own production)

The bike-train commuter combines modes to avoid unreliable public transport and decrease waiting time. Overall, tension arise in the practice of bike-train commuting when public transport, due to delays or capacity issues, is not able to provide a relaxing and time productive ride, see figure 9. We therefore suggest increasing waiting time value at stations to extend the productive time in the train to the platform, see figure 10. Furthermore, policies dealing with capacity issues and thereby increasing the level of comfort in the train is important to maintain the bike-train users.

Cycling further and navigating new intermodal routes is a challenge for the group of bike-train commuters who cycle short distances. To recraft their practice, require new materials such as a racing bike, skills such as navigating a new bicycle route to a station, and meanings such as attributing the commute exercise. Trialability policies involving tests of new materials and mobility counsel could enable an embodiment of a new practice and encourage recrafting of elements in the participants former way of commuting, see figure 10. Furthermore, overcrowded bicycle compartments in the train and poorly maintained or missing bicycle paths are influential materials pressuring the reproduction of the long-distance bike-train commuting practice, see figure 9. To recraft practices new and improved bicycle infrastructure can raise the share of bicyclists and the distance people are willing to bike, see figure 10 (Vedel et al. 2017; Krygsman et al. 2004).

The commuters who cycle longer distances struggle with the temporal pressure of the scheduled activities of everyday life, especially concerning open hours of the school or kindergarten, see figure 9. Policies prioritizing parking for specific "family-friendly" bicycles at stations or enhancing the feeling of safety on the bicycle routes in the local area could be examples of policy interventions changing how daily obligations interlock with the bike-train mode, see figure 10.

In general feeling prioritized (by not having to fight for the space in the train compartment or buying a rusty station bike so it is not stolen) can support bike-train commuting and substitute unsustainable mobility practices. Policies targeting improvements in infrastructure on the entirety of the commute empower the space where the practice can be performed, see figure 10.

To some extent, transport policy already deals with some of the findings generated in this practice study. For instance, municipalities in Denmark have run test-projects where car commuters can try an e-bike.[3] A yearly nationwide bicycle campaign that tries to create a cycle culture at the workplace is another example of measurements that already tries to get more people cycling as a part of their trip to work.[4] The bus operator of the capital region have released official guidelines to increase waiting time value by their bus stops.[5] Finally, bicycle infrastructure is an important element in the practices of biking further distances and planning agencies such as the Bicycle Highway Secretary of the Capital Region are upgrading

[3] The project "Test an e-bike" borrowed an e-bike to 1681 car commuters in the Capital Region of Copenhagen (Gate 21 2016)

[4] The "We Bike To Work" campaign had 67.000 employees participating on a national level during the month of May in 2016 (VCTA n.d.)

[5] In 2017 Movia developed several criteria to upgrade a bus stop to a "super transit node" (Movia 2017)

bicycle infrastructure for bicycle commuters.[6] However, a practice theory approach allow us to see the different necessary policies across traffic agencies, planning authorities and sectors of society. To reshape carbon based mobilities and enhance the share of bike-train commuting it is essential that the bike-train practice is seen as a unique system and the intermodal behavior of the users is endorsed from starting point to the end destination. Another vital point is to address modal shift in a larger context than the practice of commuting but also in regard to the sequence of practices in everyday life. The policies suggested in figure 10 are therefore not stand-alone strategies, neither can they work alone as policies that constrain the automobile practices is just as needed. The paper thus reveals that transport policy need to be reconfigured to support the bike-train mode as the proposed elements of interventions involve different levels of planning agencies and different sectors.

[6] The CSS have improved 206 km of bicycle route in the Capital Region of Denmark (Region Hovedstaden 2016)

PART II
Visual Analysis

1 Future bike-train hubs

This visual analysis is a result of a cooperation between Aalborg University's Master Program *Sustainable Cities* and the Cycle Superhighway Secretariat. It is carried out in relation to the Cycle Super Highway Secretariat's vision of encouraging commuters to bike more in the Capital Region of Denmark. Bike-train intermodal trips can enable commuters with longer distances to work to bike as part of their daily commute. The aim of this visual analysis is to contribute to a future planning tool that can support the intermodal commuters in the Capital Region of Denmark.

This analysis is for professionals in municipalities or others relevant actors who work with transport and mobility planning regardless of whether or not they are familiar with practice theory. We aim to inspire to short-term solutions, but also to dream about future initiatives that can radically promote and support a prioritization of the bike-train mode.

The document is an attempt to convey insights about the everyday life of bike-train commuters and how design can influence their commuting patterns. The purpose of the analysis has been to develop an assessment tool that make it possible to manage and operationalize the needs of the bike-train commuters. For this, we have developed an operational method for locating relevant stations and assessing station areas. Visual solutions of the selected stations are presented as site-specific, but in fact, they illustrate the range of the actions and solutions, to promote bike-train travel, and can in principle be transferred to other locations. The purpose is to highlight some of the issues that needs to be addressed in order to strengthen the bike-train transit in the future.

The analyses of the different stations presented here, are based on the findings of an empirical data collection which consist of 14 qualitative interviews and two different questionnaires with a sample of respectively n=1329 and n=223 bike-train commuters in the Capital Region of Denmark.
This document is an attempt to transfer the needs of the bike-train commuters directly to design in and around station areas.

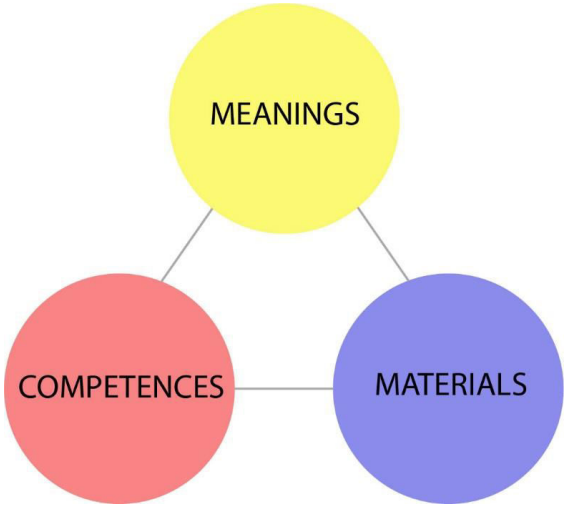
> *"This analysis is very useful. Planning tools are valuable and this analysis can help set a new agenda up through the ranks. The merging of planning perspectives across transport institutions, enable us to raise the question; who is going to step up to this challenge in the future? " Jakob Villien, Cycle Superhighway Secretariat*

More than from A to B

This visual analysis is based on the assumption that transport and commuter patterns are not just about transport from A to B, but are directly related to the obligations of everyday life. The meanings we associate with transport modes, the infrastructure and materials that we use to transport ourselves, and finally the skills we need to have in order to make the journey all influence the way we commute. In other words, the societal structures of the everyday lives of bike-train commuters are affecting how they choose to travel.

A practice theory perspective

The practices of our everyday life consist of three interrelated elements;



These three elements affect our choices, and to change or promote specific transport practices all three elements must be considered.

2 Mobility practices of bike-train commuters

A wide variety of users and different travel patterns exists among the bike-train commuters. The figure 1 illustrate a few of the compositions of bicycle and public transport found among the users.

Despite the complexity of the intermodal travel patterns, a correlation seems to exist between the mobility practice of the commuter and the distance biked on the trip.
The commuters who cycle shorter distances (<15 km) on their daily commute are partly driven and motivated by the fact that the commute enable time optimization and flexibility, while those who cycle longer distances (>15 km) are more motivated by exercise.

The majority of the short distance bicyclists cycle a part of the way and then take the train; this pattern resonates in both directions. Another pattern is identified among the long distance bicyclists, who mostly cycle the entire way in one direction and combine with the train in the other. Combining with the train one way allows people to cycle far the other way to or from work as it makes the distance more manageable and practicable - thus you do not spend too long on your transport, and you get exercise. Furthermore, the combination with train keeps people who would have stopped cycling throughout the winter, because the train allows them to vary their journey and cycle shorter distances for instance. The total travel time of those who cycle long distances is often prolonged as a result of the choice to bike longer than what is necessary. Whereas those who cycle short distances save time on their commute.

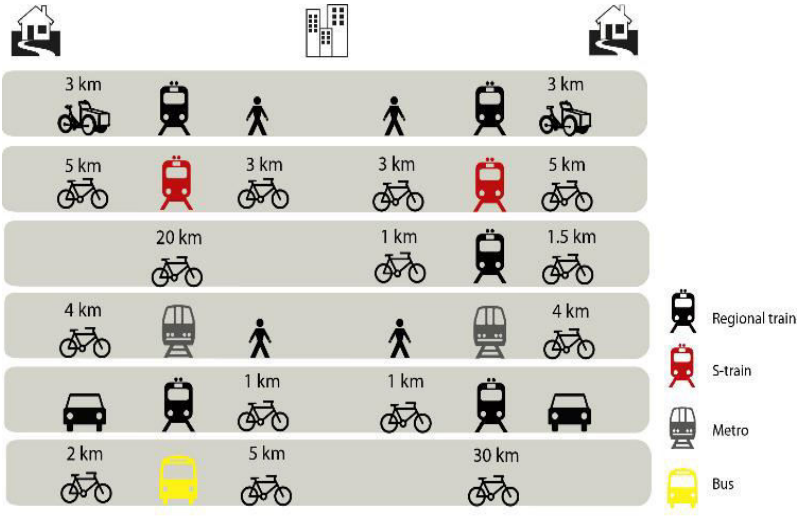


Figure 1 an example of the variety in the bike-train trips

Bicycle distance (km a day)	
<5km	53 %
5-10km	29 %
10-15km	10 %
15-25km	4 %
>25km	4 %

44-63 % combine modes every day to work

72 % have >15 km to work

63 % combine the bike with the train

54 % is satisfied with their commute

Results from Gate 21's transport survey "Moving People" and CSS survey in "Pendlerpulsen".

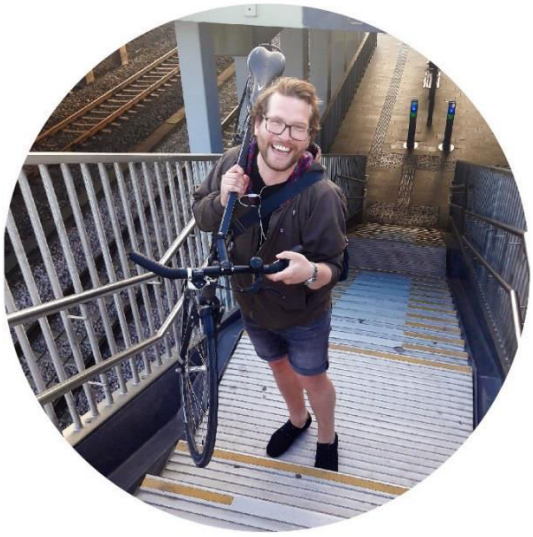
The different types of intermodal trips entail different meanings, competences and materials. The differences and the common characteristics of the short and long distance bicyclist on an intermodal trip are summarized in the figures below. Besides the difference in the distance biked on the intermodal trip, bike-train commuting requires special skills and competences of those users who have small children. To coordinate their commute with the opening hours of the kindergarten or school can be a challenge. In order to enable the bike-train trip a cargo bicycle, for example, can be indispensable. Especially cycling longer distances require a high level of planning skills as it takes a real effort to coordinate activities when the cycle trip takes up time in a busy daily life. Generally, for all, the bicycle makes the commuting trip more flexible and the combination of bicycle and train enables the best of both worlds as it is fast and flexible and the train provide a space for relaxation. Both the bicycle trip and the train trip are associated with high value.

Figure 2 Illustrates the different elements of which the short and the long distances cycle combination trip consists. The grey elements are common features that applies to both groups, while the yellow, blue and red elements belongs to the specific user group. It is therefore also the colored elements that reveal the differences of the two identified groups.

Meet the Bike-train Users

Based on the qualitative and quantitative data it can be determined that people have very different rationales and travel patterns when combining bike and train, and that bike-train commuting is connected to a high level of complexity. The following presents a sample of some of the bike-train commuting practices we have identified though our study. It is important to emphasize that these are examples and that they represent a part of all the varieties of the bike-train commuters.

"The bus actually runs at some reasonable times so you can make it to the station, but the thing about picking up kids is that it's much easier on the bike – then I can do it all at once, so combining with the bike optimize my time"



"After all, I like to bike, it gives a 25% time saving, and I think it's nice to come outside and feel the weather. But, when I'm sitting in an IC3 train, I'm happy too. It gives time for contemplation.

"I am able to combine my exercise and the trip to work. I know that many struggle to make time to go to the gym after a long day at work. The bike trip is very time optimizing. […]19 km takes a little too long, it is almost an hour each direction. So, combining is a good option"

"It is the feeling of flexibility! Cycling makes you flexible and I am not dependent of others or taking a bus or a train that can be delayed."

3 Introducing the Five Parameters

The purpose of this document is, based on the identified elements that have proven to be crucial in order to enable and retain people in the bike-train commute, to operationalize and apply this knowledge into station design and bicycle infrastructure to support and encourage the bike-train mode.

There already exist some knowledge and guidelines of best practices bicycle parking, access routes to station and to the standard of bicycle infrastructure[1]. In order to add an extra dimension to this existing knowledge base, we have highlighted the needs expressed through interviews with bike-train commuters.

We have defined five significant parameters that should be considered in any assessment of how a given station area support the needs of bike-train commuters. The parameters are: *station environment, service level, bicycle parking, access and egress,* and *bike lanes*. The setup of the parameters is based on research of experience and best practice in Denmark and the Netherlands, as well as surveys and in-depth qualitative interviews with bike-train commuters. Each parameter consist of different indicators and a series of measurable parameters. The assessment tool evaluate each station and provides an indication of how well the station and the surroundings meets the requirement of the bike-train commuter group. See appendix 1. for methods for carrying out the assessment at stations and their surroundings.

[1] Dansk Cyklist Forbund. 2007. "Cykelparkeringshåndbog" (The bicycle parking manual)

Station Environment

An aesthetic and comfortable station environment is important as the waiting time at the station should be meaningful to the traveler. Many bike-train commuters take the train because it offers the opportunity to work, relax or immerse themselves in a book. At the same time, users cycle to the station to avoid waiting time and get more freedom and flexibility. Increasing waiting time value seems to be key to minimize the annoyance of waiting. If the productive time experienced in the train already is available at the station, more bike-train commuters could be maintained by or drawn to public transport. According to the bike-train user the waiting time value is often emphasized through the importance of the fact that the station has something to offer.

Through the interviews and the stories of the bike-train commuters, it became clear that the commute is one full experience, and it is important to ensure good sense impressions both on the bike path, on the train and on the station. Sense impressions are something that they value and it seem to have an effect on their overall commute.

> *"If I should mention one station that has impressed me, it is Sydhavn Station with the sanitation they did recently. It is especially the blue LEDs hanging under the bridge. When I walk under the bridge it makes me think, wow this is cool. Before, it was really just a dark concrete bridge, but now it is a bit more open and modern with cool urban lighting" (Bike-train commuter).*

Indicator		Measurable parameters
Sense impressions	General nice pleasant feeling, appealing to senses	➢ No trash outside of trash cans ➢ No graffiti ➢ No smells ➢ No loud noises
	Safety	➢ Platforms completely lit ➢ Access points completely lit ➢ Bus stops completely lit
	Openness of station	➢ Unhindered optic lines ➢ Open air
Waiting time value	Valuable wait	➢ Interesting view from platform such as advertisement screens, urban life or greenery.
	Smaller Shops	➢ One or more shops located by the platforms in connection with the station
	Shelter on platform at departure station	➢ Roof to protect against weather on every platform ➢ Roof to protect against weather on every bus stop
	Possibilities for relaxation	➢ Benches and inviting facades to lean on at every platform and bus stop ➢ Benches to relax while waiting at every bus stops
	Urban life/activities	➢ Restaurants, playground or outdoor facilities to sit/stay or play 100 meters from station
	Aesthetic surroundings	➢ Design with extra details, art exhibition, greenery, lighting etc.

Service Level

The station area can promote and support bike-train travel through a high level of service. The high service level at stations is important in order to make the trip as comfortable and easy for the bike-train commuters. This can be assured through travel information, bicycle services and shopping opportunities.

It takes more effort to combine modes on a commute and many of the bike-train commuters are challenged by the obligations of family life, such as picking up kids and or by daily obligations such as grocery shopping. This fact makes it even more challenging for those bike-train commuters who bike longer distances, because it often prolong their total travel time. In order to promote the bike-train mode, it is relevant to look at the stations in a broader perspective than it has been the case so far. Peoples commute and therefore also the station at some point, is a part of the everyday practices. Based on this argument, it is relevant to assess a station's potential to support the bike-train commute based on service facilities that relate to people's daily lives and daily activities, such as possibilities to buy groceries, shopping options, fitness center, pharmacy, delivery boxes or bicycle repair.

> *"I sometimes take my car because then I have the opportunity to go shopping when I come home. There is no change I will go grocery shopping on my way home if I take the bicycle or the bus" (car-train-bike commuter).*

> *"We receive meal boxes on a weekly basis in order to make the daily life fit together/add up" (bike-train commuter).*

Indicator		Measurable parameters
Travel information	Access to travel information	➢ Electronic updated departure/arrival times in connection with all transport modes (located at access points at s-train, bus and metro) ➢ Map of operating lines by all platforms and bus stops
	Access to ticket machine	➢ Ticket machine in proximity to travel information
Bicycle service	Station bikes	➢ Donkey Republic ➢ Bycyklen
	Do it yourself repair	➢ Bicycle pump, etc. close to the bicycle parking
	Bicycle repair shop	➢ Shop in 200 m proximity to platform
	E-bike service	➢ Charging possibilities for e-bikes
	Other services	➢ Locker for stuff/drinking fountain etc.
Daily life services	Advertisement	➢ Electronic screens
	Other services	➢ Delivery boxes/ package service 7-elleven /gls kiosk
	WiFi at station	➢ Connecting to WiFi at the waiting areas
	Car sharing	➢ Car sharing parking spots, number of FF-cars in 200 m proximity
	Taxi service	➢ Taxi parking lots
	Shopping	➢ Grocery store in proximity ➢ Drugstore ➢ Other
	Newspaper	➢ Free newspaper stands at station
	Fitness center	➢ Fitness 200 m from station

Bicycle Parking

Among the user group there is a wide variety in types of bicycles. Several of the interviewed bike-train commuters are not comfortable parking their good bike at the station, and therefore have an old rusty bike that will not attract any attention. Some have expensive bicycles mainly used for longer distances and others have cargo bikes.
Among the bike-train users who park their bicycle at stations two factors seems to be of most importance: close proximity to the train, and security of the parking facility. Several interviewees mention the risk of having their bike stolen as a barrier to park their bicycle at the station.

The bicycle parking must therefore enhance and ensure the flow and offer high levels of security. A study has found that security of the bicycle parking is an even bigger concern for the people who does not already bike[2] to a public transport node. This means that it is extremely important to ensure high standards of bicycle parking where people can lock the bicycle frame to something and park a variety of different bicycles. This could prompt more people to combine with bike and train.

The bicycle parking at stations must meet the variety we see in the overall bicycle fleet, for instance 25%[3] of all families with two children in Copenhagen owns a cargo bike, which means that a significantly larger share of the parking for special bikes must be allocated on every station.

> *"I park my bike where is can attach it to something" (bike-train commuter).*
>
> *"I am not comfortable parking my expensive racing bike at the station" (bike-train commuter).*

	Indicator	Measurable parameter
	Sufficient number of parking spaces	➢ Occupation rate less than 90% and more 80 % in peak hours
	Proximity to platform	➢ Less than 5 % of the bikes parked outside of the parking area* ➢ Are all parking facilities less than 50 m away from station?
	Secure parking facilities	➢ Access to locked bike parking ➢ Access to parking where a bike can be secured with a chain ➢ Surveillance cameras in parking area (minimum one area)
	Sheltered parking	➢ Access to sheltered bicycle parking
	Parking for special bikes	➢ Extra room for cargo bikes or other special bikes
	Travel information	➢ Travel information in close proximity to bike parking (can you get information from bike parking)
	Access to bike parking	➢ Bike path in connection with parking facility ➢ No sharp or steep access points (curb) ➢ A minimum 2 m wide stair/access point with ramps if in other level
	Signage	➢ Signage leading from the bicycle path entries to the parking space
	Flow	➢ Short distance from platform to bicycle parking (1-2 minutes)
	Order and cleanliness	➢ Disused or abandoned bicycles
	Safety	➢ Lighting
	Aesthetics	➢ Special design features at the parking area

[2] Movia. 2017. "Superskiftet - En guide til planlægning af gode skifteforhold mellem cykel og bus"
[3] Thomsen, M. 2017. "København tredobler parkering til ladcykler" TV2 Lorry
https://www.tv2lorry.dk/artikel/koebenhavn-tredobler-parkering-til-ladcykler

Access and Egress

The sense of continuous flow is essential for the bike-train commute to be attractive to the users. This applies to both those who cycle long distances and take a bike on the train in one direction, and those who cycle shorter distances and park the bike at the station. The individual mode of the bicycle gives freedom and flexibility; a feeling that can be extended to public transportation, if the access and egress feels easy and frictionless.

Stairs and other barriers at the stations and general aspects related to shifting modes provoke resentment among the commuters. Access routes to and from the station without a curb, intersections etc. are therefore important, as well as a good and fast access to and from the platform. The closer to the platform or bike parking you can cycle, the better the flow will feel.

"I can bike almost right into the train, it is really nice" (bike-train commuter).

Indicator	Measurable parameter
Ramps for bikes	➢ Ramps by all platforms ➢ Ramps (both ways) to all platforms
Elevator	➢ Elevator by all platforms
Wide stairs	➢ Are all stairs to the platforms 2 m wide?
Exits	➢ Are there platforms with multiple/several exits?
Flow	➢ Does it take less than 1-2 minutes to get to/from the platform to the bike path away from the station ➢ Does all the bike paths connect with the station area? (map problematic missing links) ➢ Is the majority of the platforms level to the bike path
Signage	➢ Signage to/from the station to the SCS
Travel information	➢ Travel information by ramps/elevators or other cyclist access points

Bike Lanes

No matter whether the bike-train commuters cycle 15 km or 2 km to the station, the bicycle infrastructure is an important factor. Studies from both the Netherlands[4] and Denmark[5] show that there is a correlation between the distance the bicyclists are willing to bike on their everyday commute and conditions of the bike lane such as, traffic lights, designated bike lanes separated from other traffic, or routes with a green backdrop. The more interruptions on the way to the station, the shorter distance is the cycling catchment area of the station. Better cycling infrastructure to and from the station can therefore encourage more to cycle further on the bike-train commute.

The two surveys suggest that the bike-train commuters compared to the general commuter are more likely to perceive better bicycle infrastructure as a motivating factors that could encourage them to bike more. Some value the direct, straightforward bike lanes, while other appreciate exciting and scenic routes.

> *"It's simply too inconvenient. The bike path turns left and right and you have to cross some smaller roads, which is probably the worst, as I will lose my speed and flow. It's far more fun to cycle where there are no intersections. Personally, I would always use a bicycle highway if it was an option, as it is more efficient, and then I would probably cycle even more. It would be more enjoyable and the trip would feel faster, even if it is not" (bike-train commuter).*

Indicator		Measurable parameter
	Separation from other traffic	➢ Separated bike lanes with a curb to or from the Cycle Superhighway
	Surface state	➢ Asphalted bike lanes without holes to and from the Cycle Superhighway
	Lighting	➢ Lit bike lanes to and from station and the Cycle Superhighway
	Continuous paths	➢ No traffic lights/intersection to and from station to the Cycle Superhighway
	Scenic route	➢ Greenery or urban environment on the path to and from the station to the Cycle Superhighway
	Flow	➢ No obstacles that forces one to stop or sidestep when cycling to and from the Cycle Superhighway
	Access routes to station	➢ Several routes from the station to the Cycle Superhighway
	Measure of bike lane	➢ At least 1,7 meter wide

[4] Krygsman, S., Martin Dijst, Theo Arentze. 2004. "Multimodal public transport: an analysis of travel time elements and the interconnectivity ratio." *Transport policy*. Volume 11. P. 265-275c

[5] Vedel, S., Jette Bredahl Jacobsen, Hans Skov-Petersen. 2017. "Bicyclists' preferences for route characteristics and crowding in Copenhagen: a choice experiment study of commuters". *Transportation Research*. Part A: Policy & Practice, Vol. 100, 2017, p. 53-64.

4 Selection of Bike-train Hubs

A screening of all train stations in the Capital Region of Denmark has been carried out in order to select potential case sites, which can serve as an inspiration for the work on future bike-train hubs.

Based on our empirical data we know that connectivity is crucial for bike-train commuters. They cycle longer to reach a direct connection and want more than anything to avoid shifts between public transport modes. It is a matter of saving time, having more connections to choose from, thus reducing travel time and ensuring a continuous stay in the train for relaxation.

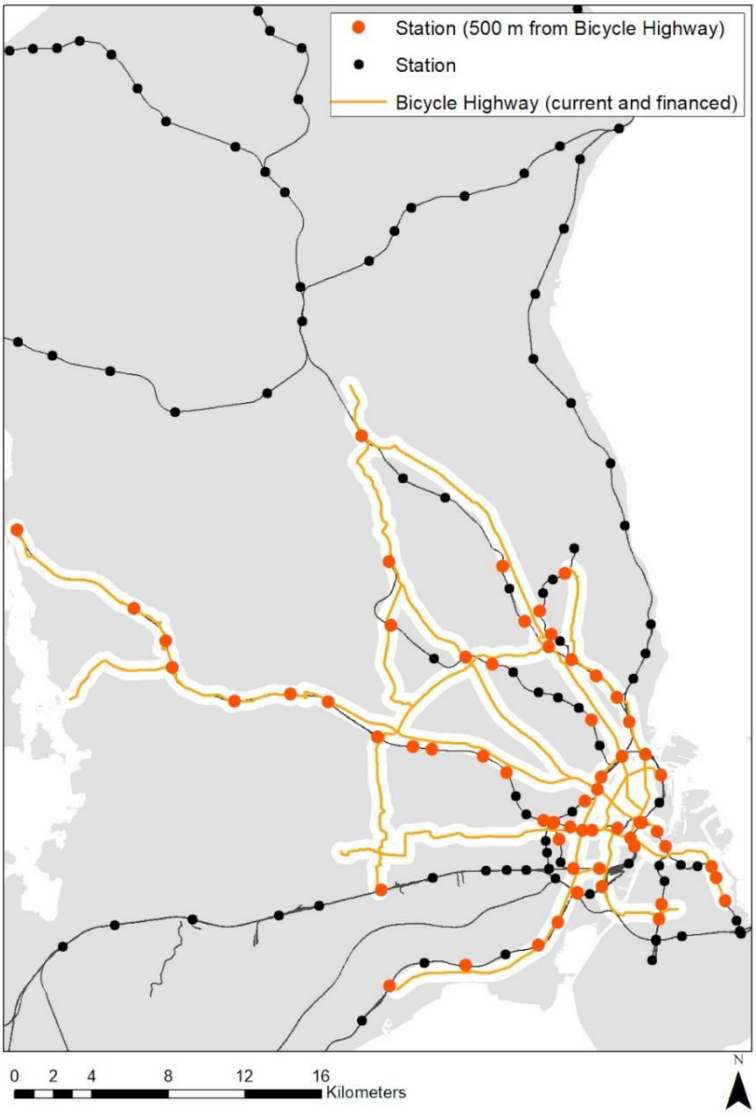
> *"I could bike to Lejre Station it is actually a little closer than Roskilde Station. But not as many trains run from Lejre Station as from Roskilde Station. That's why it's not relevant at all" (Bike-train commuter).*

In order to use the proposed method of the 5 parameters for evaluating the station and station area, it is necessary to identify possible sites where central needs of the bike-train commuters should be met to promote the mode. Some stations are naturally more qualified than others are. In the following steps, we identify stations using a filtering exercise. Based on the users' preferences we have decided to set up three requirements for selecting potential bike-train hubs where extra effort is required to support bike-train commuting. The first is that the station maximum must be located 500 meters from a Cycle Superhighway. The second is a requirement of high frequency. While the third is an option to use several different modes of public transport.

We have sorted the stations located in the Capital Region of Denmark, in a GIS analysis, to determine which stations are preferable for bike-train commuters.

500 m to a Cycle Superhighway

The cycling trip is an important part of the bike-train commuters' trip and needs to be prioritized as much as the trip by train. Experience from the Netherlands show that; the more interruption in the flow on the bike lane the shorter distance people are willing to cycle to the station[6]. We therefore suggest that the first criteria for the station to be viable as a "bike-train hub", which supports the bike-train user group, is therefore proximity to a bike lane of a certain quality in terms of providing a good flow for the user. We can approach this issue in two ways; by selecting stations that are already connected to quality bike lanes or use the analysis to pinpoint where new infrastructure should be constructed. In the following visual analysis, we have chosen to identify station that already have the necessary bicycle infrastructure, as a starting point for improvements. In this case, the Cycle Superhighways have been selected as desirable routes as they, in theory, provide an infrastructure satisfying for the bike-train commuter.



Map 1 Stations located near a Cycle Superhighway. Own production

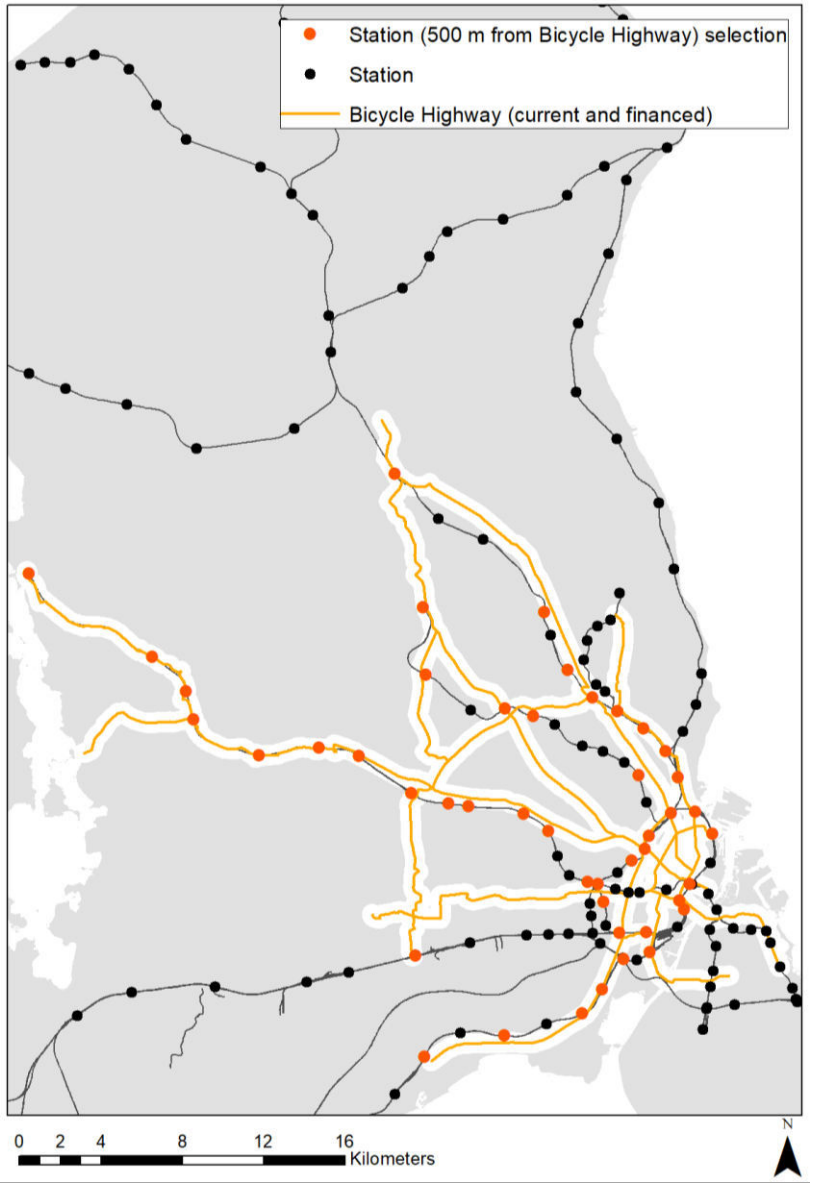
Step 1:

A buffer of 500 m is set to guarantee good bike infrastructure as close as possible to the station. This resulted in the potential hubs being narrowed down to 61 stations (orange dots) as displayed in map 1, above.

[6] Krygsman, S., Martin Dijst, Theo Arentze. 2004. "Multimodal public transport: an analysis of travel time elements and the interconnectivity ratio." *Transport policy*. Volume 11. P. 265-275c

Transport Options

The bike-train commuter combines modes to get more flexibility, more transport options and to avoid transit between different public transport modes. The speed of the public transport mode is crucial if the mode is to compete with the car. Therefore, fast modes of public transport have weighed more in our selection of possible "bike-train hubs".



Map 2 stations located near a Cycle Superhighway with high speed modes

Step 2:

The second criteria for the station to be viable as a hub, is to only consider public transport with a relatively high speed and frequency. As an example, only express buses are considered in the calculation as a study has found that 85% of all cyclists that arrives to either a R, E, or S bus, arrives by bike[7]. Furthermore, stations with only local train lines have been disqualified due to low frequency. Stations, which are, only equipped with a metro line are filtered off, as the average speed of 40km/h is lower than the other forms of trains and due to the fact that you cannot bring a bicycle on the metro during rush hour. Furthermore, the metro only operates inside the city boundaries and does not cover as big a geographic catchment area as the train, which does not correspond well with the bike-train users' average commuting trip of 26 km. This narrowed the potential "bike-train hubs" down to 44 stations as displayed (orange dots) in map 2, above.

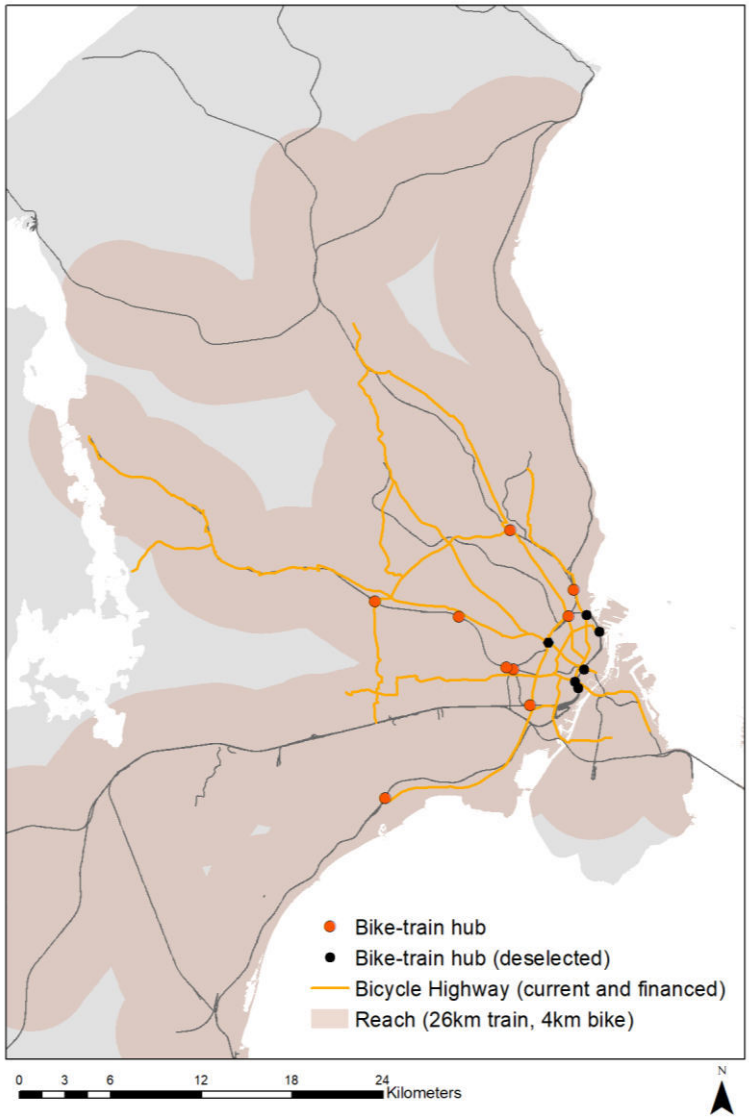
[7] Movia. 2017. "Superskiftet - En guide til planlægning af gode skifteforhold mellem cykel og bus"

High Frequency – Minimizing the Waiting Time

The waiting time is identified as a critical element of the bike-train practice, and many respondents chose to bike to high frequency stations in order to avoid waiting time on their commute. When the waiting time is minimized the total experiences of interruptions on the commute is also minimized, which is crucial for the bike-train commuter.

"I often experience to wait at the bus. That I don't have to do with my bike. So, the bike reduces my waiting time, and that is great" (Bike-train commuter).

The bike-train commuters also value a flexible arrival at stations. A high frequency of arrivals and departures from the station means that they do not have to check timetables before they leave home.



Map 3 qualified bike-train hubs

Step 3:

Three different criteria were considered; availability of different modes of transport, frequency of available modes of transport and number of daily passengers at the station. The criteria were chosen as the user group demands low average waiting time. This demand is reflected in high frequency and high level of connectivity, which is related to many modes of transport and lines. We calculated the waiting time in frequency of departures per hour for every fast available mode of transport at every selected station. The available fast modes of transport were express busses (R, E, S), S-trains, regional trains, intercity trains and metro. Research of passenger count a day was carried out to solidify that if the station was upgraded to a "bike-train hub", it would impact as many passengers as possible. These three criteria were treated equally, and the 15 stations, which had the highest score, would be subject to further research. The final 15 potential hubs are displayed as orange and black dots, see map 3, above.

Final Step

All 15 stations on the map 3 are potential "bike-train hubs" according to our estimates of the current transport system. That being said, new infrastructure projects in the capital region such as the light rail and new metro ring opening in 2019, might open up for other potential stations. The selection analysis above should therefore be renewed and repeated regularly. In the following analysis, we choose to work with nine of the 15 hubs (all the orange dots). The black dots on the map include potential hubs located in the central part of Copenhagen. These are Copenhagen Central Station, Nørreport Station and Vesterport Station, which all are located in zone 1. Today many arrive by foot to stations within zone 1 but Copenhagen Central Station and Nørreport Station have great potentials for future arrivals by bicycle[8]. The Municipality of Copenhagen are already engaged in projects exploring the possibilities for better conditions for the bike-train user group[9]. The following station analysis will therefore investigate some of the stations, that have not been given as much attention in regard to bike-train travel. In addition, Nørrebro is deselected because the area is currently undergoing extensive renovations in relation to the opening of the new metro line[10]. Furthermore, Vesterport, Nordhavn and Svanemøllen Station have a high frequency of S-trains, but they only have one mode of public transport, which does not meet the requirements we have set according to the bike-train user group and these are therefore deselected in the analysis.

The selected nine possible "bike-train hubs" will be further investigated in the forthcoming sections: **Ballerup Station, Flintholm Station, Hellerup Station, Herlev Station, Ishøj Station, Lyngby Station, Ryparken Station, Valby Station**, and **Vanløse Station**.

The nine selected stations have different characters as they both have different traffic functions and surroundings. Some are *suburban nodes*, which is characterized by having one type of train and several express bus lines, which extend into the catchment area. *The regional node,* which has several train connections that stretches further out in the region and the rest of the country and several bus lines. *Urban nodes*, which are stations that has connections that extend across the city and bus lines. Finally, there are differences in the urban context of which the stations is a part and the number of daily passengers. Despite the differences in the types of journeys carried out at the various stations, it is common for all stations that they have more means of transportation with high frequency and therefore are interesting in a bike-train perspective.
The following part will present station analyses of the nine selected stations.

[8] Gehl Architects & MOE Tetraplan. 2018. " Overflytningspotentiale fra bil til kombinationsrejser med cykel og tog"
[9] The Municipality of Copenhagen. 2018. "Prioriteringsplan for cykelparkering 2018-2023"
[10] Metroselskabet. 2018. https://www.m.dk/#!/stations/byggepladser/noerrebro+station/om+byggepladsen+noerrebro/nyheder/vi+indretter+stationspladsen

BALLERUP STATION AREA

- Waiting time value

Ballerup Station is located along the highway Ring 4 surrounding Copenhagen. The station dates back to 1879. Due to the age of the station the city have expanded from it, and it has become the natural center of Ballerup. The area where the station is located is mainly commercial, e.g. Ballerup shopping center is located in the same building as station building. Furthermore, the station encompasses a large bus terminal connecting several express busses with the area.

S-train lines: C H

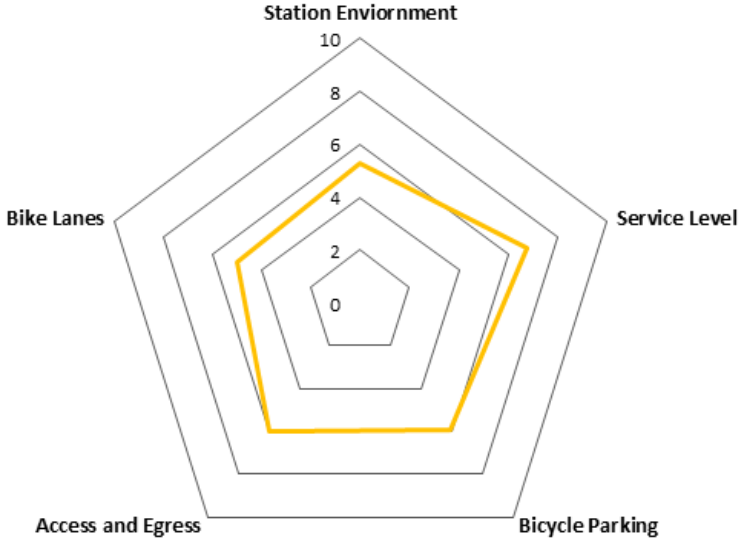
Bus lines: 42, 143, 144, 147, 156, 157, 216, 400, 350S, 400S, 500S, 834, 835

Amount of bicycle parking: 774

Bicycle parking occupancy rate: 58%

Train: 16.400 passengers a day

MAPPING OF THE CURRENT STATE



1

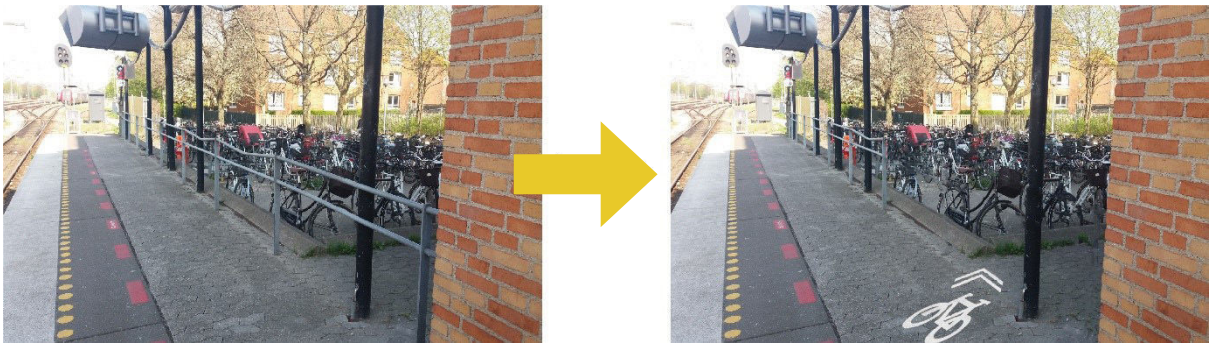
Ballerup Station scores low on station environment as it is quite chaotic, unorganized and outdated. The platforms of the station are uninspiring, see picture 1, thus decreasing waiting time value. The bike-train commuter combines modes to minimize the waiting time on their trip. Increasing the waiting time value on the station might make unforeseen delays and cancellations more bearable for the users. Furthermore, the access and egress for the bike-train commuters are uncomfortable by restricting structures, such as fences, many of which seem to serve no purpose other than decrease the flow of the bicylist arriving to the station, see picture 2.

2

POTENTIALS FOR SHORT TERM IMPROVEMENTS

The initial actions that can be taken to improve Ballerup Station is an overall cleanup of leftover building materials, sand, traffic cones and so on. The platforms should be equipped with greenery, recreational objects and screens for entertainment, to increase the waiting time value for the stations users, see picture 3. Furthermore, the bicycle parking could use a similar upgrade, so that it is better integrated to the station, providing a smoother flow for the bike-train commuters when they arrive to the station by bike. This could easily be done by removing the restrictive fence, which is currently blocking the flow, and adding a marking on the floor to draw attention to the nearby bicycle parking, see picture 4.

Picture 3: Suggestions for increased waiting time value. Top left corner; greenery and benches on Lyngby station. Top right corner; bookcases where travelers can exchange books. Bottom left corner; art exhibition on Gloucester Road subway. Bottom right corner; movie projections on Malmö Central station



Picture 4: the barrier between platform and bicycle parking has been removed and a marking on the ground have been added to draw attention to the nearby bicycle parking.

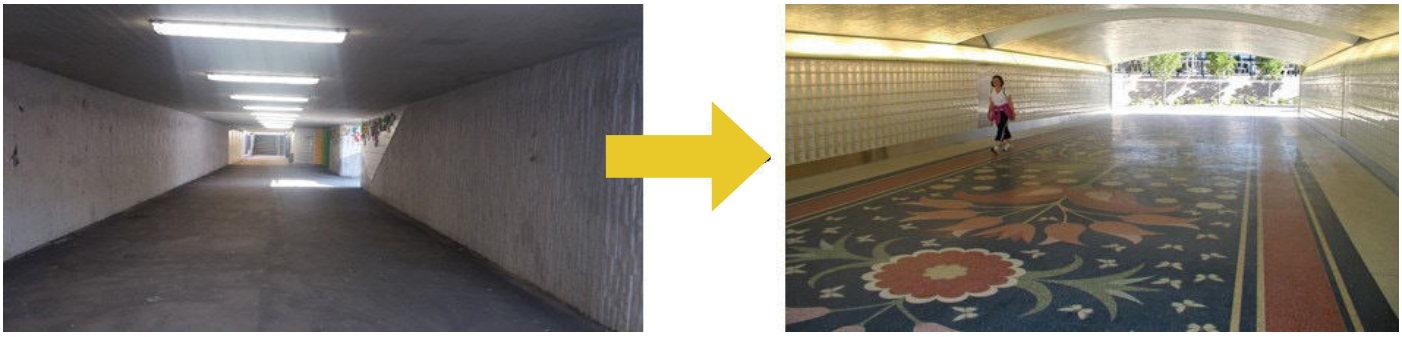
LONG TERM RECOMMENDATIONS AND SYNERGIES WITH OTHER PROJECTS

Ballerup Municipality is currently working on transforming the nearby bus terminal into an urban space with cafes and shops, that will provide a better connection from the station to the rest of downtown Ballerup, see picture 5. It would be natural to include the rest of the station in the project, e.g. platforms and entries, to enhance the overall waiting time value. The vision for this transformation is to rethink and revitalize suburban cities and in line with the collaboration between Realdania and Ballerup Municipality. The reason why it is the bus terminal that was selected for revitalization, is that the area is the first thing many visitors see. It could be argued that it is just as important to renovate the station, as the same logic applies to the train station. We therefore suggest a thorough renovation of the whole station area, and not only the bus terminal, to improve on the waiting time for the users and to create a station environment that is welcoming to visitors.

Picture 5: Ballerup Municipality's concept drawing of the urban space on the old bus terminal space.

As of now, the platforms of the station have very limited views due to the closed facades of the station building on one side and Ballerup shopping center on the other side. We therefore suggest focusing on the content of the platforms to start with. This could be done by transferring and expanding the organic and green theme of the urban space at the bus terminal to the platforms, see picture 6. Furthermore, the two tunnels that function as corridors under the tracks and access points to the middle platform, are uninspiring and unsanitary. The tunnels would benefit from an overhaul by improving lighting and by installing art or mosaic floors, see picture 7 on next page.

Picture 6: Green transformation of the platforms on Ballerup station. Inspiration from Britomart station in New Zealand.



Picture 7: The barrier between platform and bicycle parking has been removed and a marking on the ground have been added to draw attention to the nearby bicycle parking.

In the long-term visions for the station area as a whole, it would be beneficial to provide better connection between the bus terminal, the train station and the surrounding infrastructure and city life. To do this, it might be necessary to open the facades of the surrounding buildings and to create more corridors between the different functions.

Potential actors:
Danish Rails (DSB)
Ballerup Municipality
Realdania (developer)

Potential partnerships:
Local restaurateurs
Local business owners
The local library

Potential stakeholders:
Citizens

FLINTHOLM STATION AREA

- improved bicycle catchment area

Flintholm station is located in Frederiksberg and has both metro and S-train lines. The station was renovated in the early 2000 when the metro line was inaugurated[1]. Copenhagen Business School is located right next to the station. The platforms of the station are covered by a 5000 m² glass roof. The overall station design is open and spacious and have won numerous awards[2]. The station is also in the unique situation that it is wedged between the municipal boarders of Frederiksberg and Copenhagen municipality

S-train lines: C H F

Metro lines: M1 M2

Bus lines: 9A 10 13 21 34 142

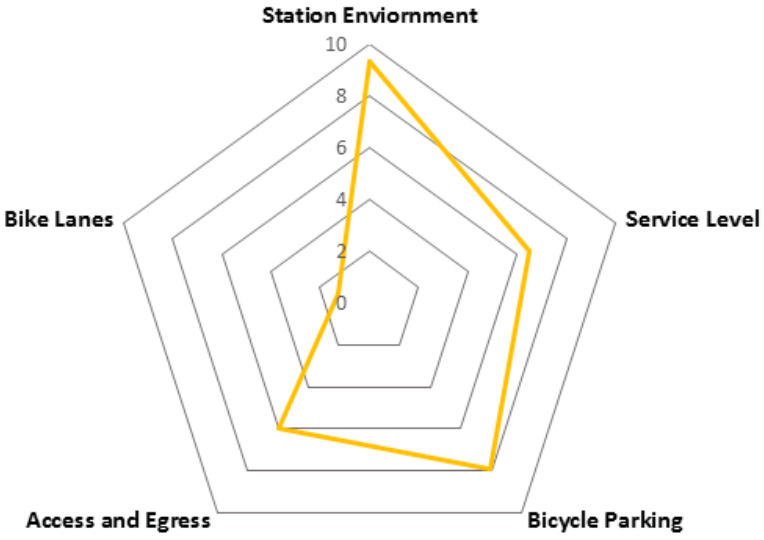
Amount of bicycle parking: 994

Bicycle parking occupancy rate: 83%

Train: 15.700 passengers a day

Metro: 9.535 passengers a day

MAPPING OF THE CURRENT STATE



Flintholm has several architectural details and inviting waiting areas to sit for passengers, which is also reflected in the overall station environment score. The high score is in large part due to the overall maintenance and aesthetics of the station. Furthermore, the service level of the station with two separate bicycle shops, water fountains and convenience shops. Another thing to highlight is the flow from bicycle parking to platforms where the station also excels. However, there are issues with the bicycle lane network connecting the station and the Cycle Superhighway. The Cycle Superhighway route closest to the station is the Albertslund route. The bicycle parking on the north-western part of the station is of low quality resulting in a high number of bicycles parked outside the racks.

Picture 1: Overview of the platforms of the station and the spaciousness

Picture 2: Good flow from bicycle lane to bicycle parking to platforms.

[1] DSB. 2004. "Flintholm station indviet." https://www.dsb.dk/om-dsb/presse/nyheder/flintholm-station-indviet/

[2] Børsen. 2005. "Designhæder til DSB." Børsen, september 15, 2005

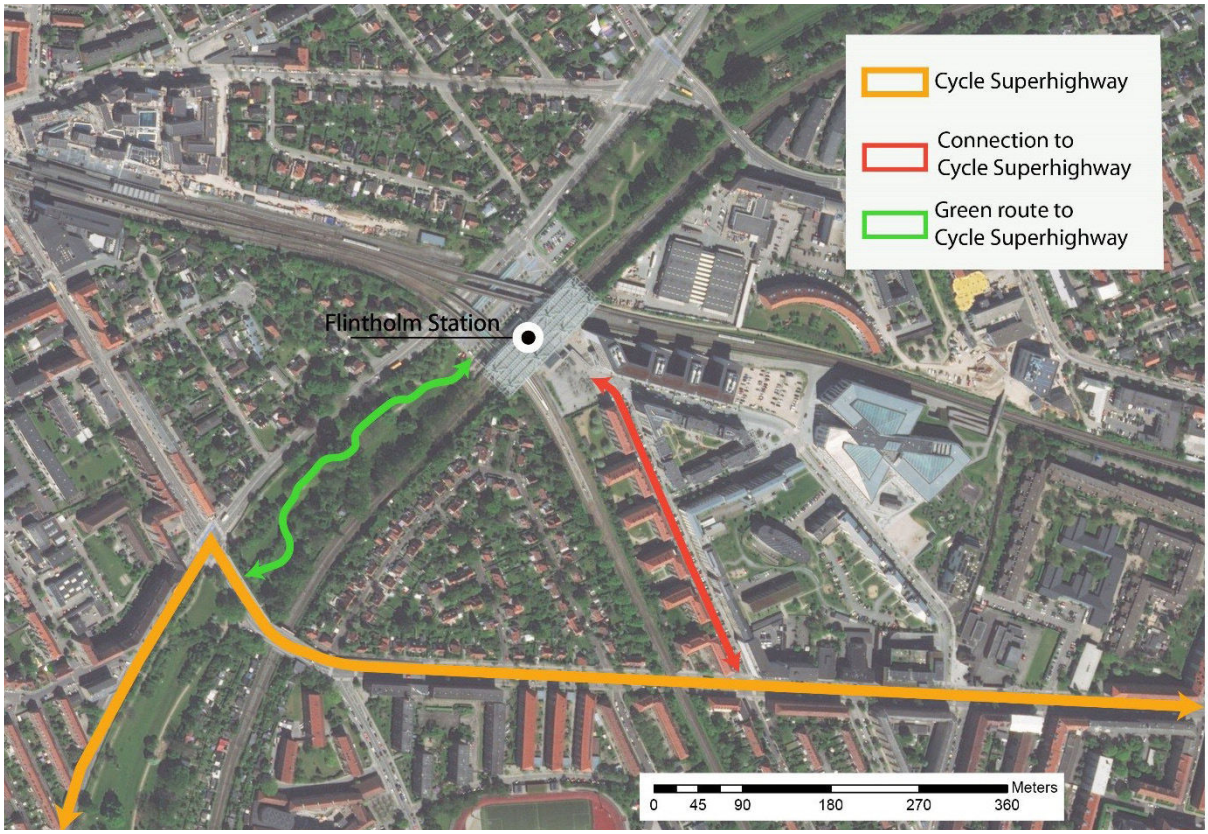
PONTENTIALS FOR SHORT TERM IMPROVEMENTS

To realize the potential of Flintholm Station, it is necessary to establish more and better connections to the Cycle Superhighway, two such connections are presented in the map below. We suggest to make one regular connection and one green connection, as it is found that the combination travelers have different preferences that shift on a day to day basis. To improve these two connections, some problematic structures needs to be addressed.

Picture 3: The gate separating the green route from the Cycle Superhighway

On the green route, it will be necessary to dedicate one of the paths through the park for bicyclists, as it is currently reserved for pedestrians, see picture 4. Furthermore, at the end of the park there is a gate which separates the green route from the Cycle Superhighway, see picture 3. This gate is locked at 6pm. For the convenience of the bike train users, the gate would have to be open at all times.

Picture 4: pedestrians blocking the green route for the bicyclist



Picture 5: no separation between bicyclists and motorists on the feeder road to the Cycle Superhighway

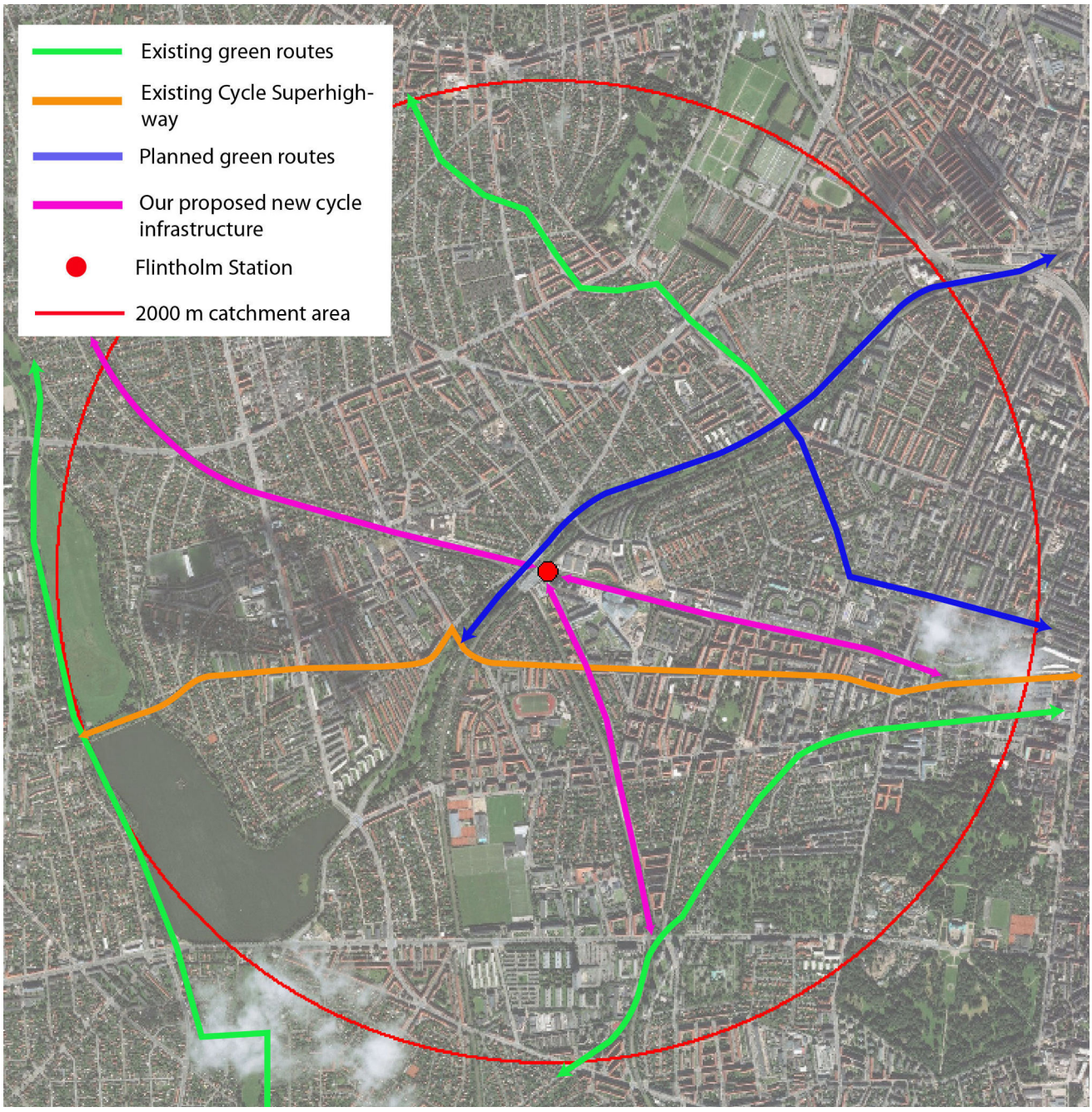
On the regular route, we suggest constructing a separated bicycle lane to increase the safety of the cyclists. Instead, the existing cobblestones on the bike path should be replaced by asphalt to increase comfort. The road is narrow, so it might be necessary to remove the parking spaces on the right side of the road, see picture 5.

Picture 6: New suggested structure of the road, Elmegade Copenhagen

LONG TERM RECOMMENDATION AND SYNERGIES WITH OTHER PROJECTS

In a long term perspective, it can be beneficial to keep on focusing on the connectivity of the station, but in a larger scale. Currently, the rather conservative catchment area of a station for bicyclists are considered to be 2 km in Denmark. When examining the current catchment area of Flintholm and existing bicycle infrastructure plans, it is found that plans exist to expand the green route network of Copenhagen to run past Flintholm station[3] and connect with the Albertslund Cycle Superhighway, see map below.

When this is established, the accessibility of the station is improved greatly for the bike-train commuters. However, we argue that the connectivity could be improved even further by establishing either Cycle Superhighway or green route along the tracks leading to and from Flintholm, see map.



[3] Københavns Kommune. n.d. "Grønne cykelruter." Accessed June 6, 2018 https://www.kk.dk/groennecykelruter

If the proposed infrastructure is established, it is important to maintain the flow of the cyclists. The transition from Super Cycle-highway/green route to station environment should be seamless and without obstacles to achieve the highest effect, see picture.

Potential actors:
DSB Ejendomme
Municipality of Frederiksberg
Municipality of Copenhagen

Potential partnerships:
Cycle Superhighway Secretariat

Potential stakeholders:
Citizens
Homeowners along planned infrastructure

Picture 7: Seamless transition from cycle infrastructure to bicycle parking and platforms. Utrecht, the Netherlands.

HELLERUP STATION AREA

- Quality bicycle parking

Hellerup station is located on the outskirts of Copenhagen Municipality and bordering on Gentofte Municipality. The station is placed 700 meters from the main street “Strandvejen”. There is not great potential for urban development because of the functions and service already existing in the adjacent shopping street. The station is, however, one of several vital connections to the cities along the coastline of northern Zealand from the center of Copenhagen.

Train lines: REGIONAL

S-train lines: C B F E

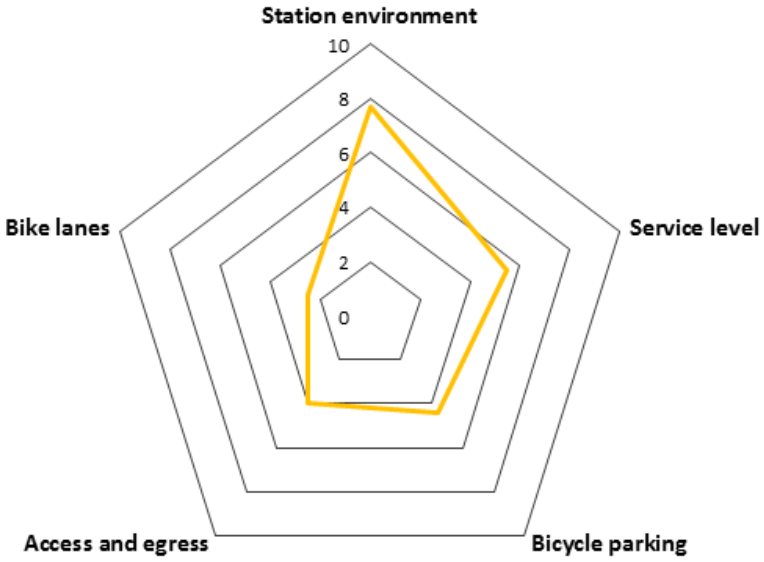
Bus lines: 21, 166, 169, 179, 192, 1A

Amount of bicycle parking: 766

Bicycle parking occupancy rate: 74%

Train: 29.400 passengers a day

MAPPING OF THE CURRENT STATE



The service level at Hellerup Station enable commuters to run errands such as grocery shopping or pick up package/ post on the way to and from work. The possibilities to travel on by bike is also enhanced by two station bike services, Bycyklen and Donkey republic.

The current bicycle parking has around 300 sheltered parking spots. The quality of the racks is unfortunately low. 70 of the “bicycle hooks” are broken, see picture 1. 10 % of the bikes in the station area are parked outside of the rack as there are no option to lock the bike to something. The station scores very low on access and bike lanes. The access points are few for the bicyclists using the bike lane running past the main entrance of the station. They have to cross a tunnel or walk the bike over two pedestrian crossings to get to the platform. The flow from the bike lane is thereby non existing, see picture 2.

1

2

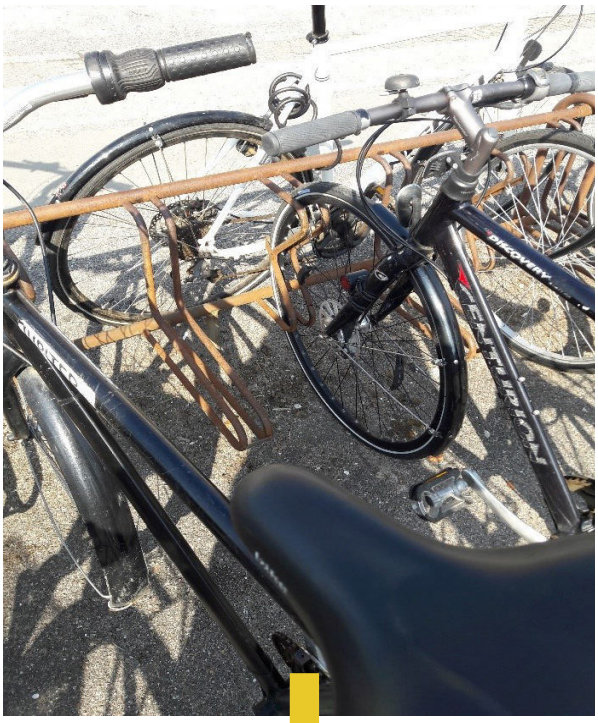
PONTENTIALS FOR SHORT TERM IMPROVEMENTS

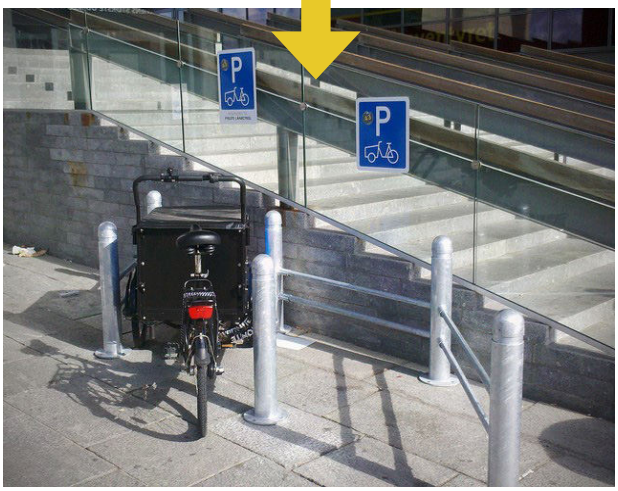
Arround 40 % of the bicycle parking at Hellerup Station is sheltered. The majority of the parking is placed right by the platform or at entrance points to the platforms. Despite of these qualities the bicycle racks are old and worn down and the safety level is low, see pictures 3 and 4.

We suggest that new parking racks for different types of bicycles are constructed as one of the first improvements at the station. It is essential to enhance the feeling of conveince and safety for all bike-train commuters to promote the mode, see picture 5 and 6.

Picture 3: No room for special types of bikes make it difficult to find secure parking for commuters with cargo bikes.

Picture 4: Worn down and rusty racks enhance impressions of disuse, that it is unsafe and that bicycle commuters are not prioritized at the station.





Picture 5: Room for everyone: Prioritized cargo bike parking by Fields shopping center

Picture 6: Secure charging locker for e-bike batteries at Lyngby Station

The municipality of Copenhagen estimate that the need for bicycle parking at each station in the city can increase with 25 % from 2018-2025 due to the increase of inhabitants. Prognoses of the development in passengers at Hellerup Station indicate that the station will need 1161 extra parking racks by 2025[1]. If the potential of bike-train trips is unleashed and 50 % of the trips to the station are made on bicycle, as in the Netherlands, the number of bicycle trips per day to Hellerup station could triple[2]. In this scenario the need for bicycle parking may be significantly higher than estimated by the municipality.
In the ongoing process of building more bicycle parking in the Municipality of Copenhagen, improveing the quality of parking facilities is essential. Today 25 % of the families in Copenhagen with two children own a cargo bike[3] and the possibility to pick up or drop of children can be a vital part in the practice of bike-train commuting. Furthermore, racing bikes and new generations of e-bikes such as the speed pedelecs are entering the market and the costly bikes need different secure facilities than offered today. The main challenge at Hellerup Station must therefore be to provide enough bicycle parking for all the different types of bike-train commuters.
At the moment, obstacles such as fences, narrow entries and stairs make it difficult to access the parking facilities. At the same time access and view to the platform are blocked at the station entry by a series of buildings; hindering the flow of the access and egress at the station, see pictures below.

Top picture: Building owned by the DSB blocking the view to the platform. **Down left:** Narrow passage from the bike shed to the station. **Down middle:** Garbage containers by the bike share system "Bycyklen". **Down right:** Fence restricting the access to the platform.

[1] Teknik & Miljøforvaltningen. 2018. "Prioriteringsplan for cykelparkering" Københavns Kommune.
[2] Gehl, MOE & Tetraplan. 2018. "Overflytningspotentiale fra bil til kombinationsrejser med cykel og tog." draft.
[3] Københavns Kommune. 2017. " Nemmere at parkere ladcyklen i København" published 02.01.2017 at https://www.kk.dk/nyheder/nemmere-parkere-ladcyklen-i-koebenhavn

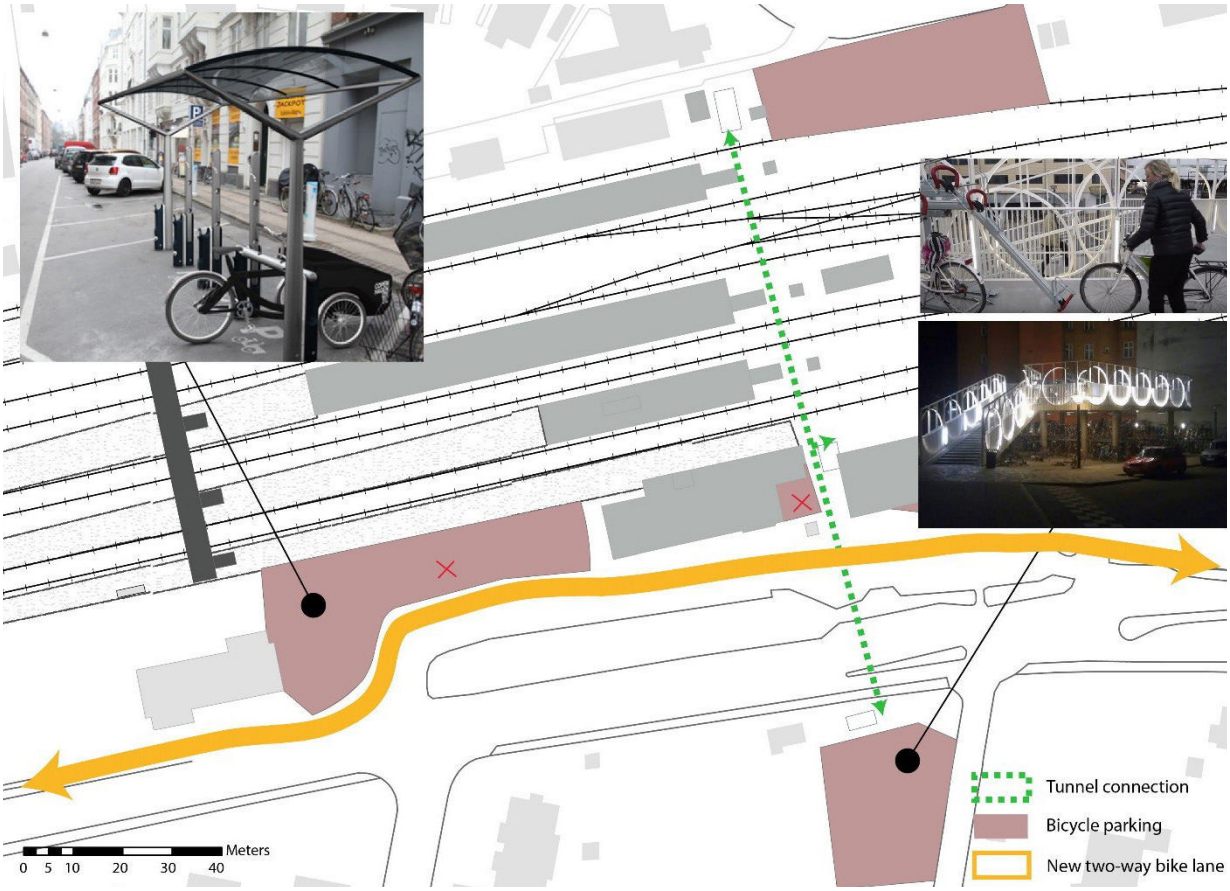
LONG TERM RECOMMENDATION AND SYNERGIES WITH OTHER PROJECTS

We suggest that two buildings are demolished at the station front and entry to give room for bicycle parking close to the platforms and to create unhindered visual lines when arriving at the station. Furthermore, safety and attraction of bicycle parking placed further from the station platforms should be increased by using interesting design and secure bicycle racks for different types of bicycles, see map below.
The map illustrates current and proposed established bicycle parking areas (X) at Hellerup Station. The pictures on the map is placed to inspire different solutions. The picture of the parking facility in two storages showed on the map is located at Odense Central Station, Denmark, and contain multi-story bicycle racks with a fork support and a locking system. The facility is more than 100 meters from the station but experience a high occupancy rate[4]. The second picture show a concept drawing of cargo bike parking placed in the streets of Copenhagen by Copenhagenize.

A future Cycle Superhighway is planned to run past the station front. Today the one-way street for busses and taxis by the station prohibit bicycles from accessing the station from both directions of the bicycle route. The current access and egress points to and from the station and the future Cycle Superhighway should therefore be secured by a two-way bicycle path, see proposal on map.

Potential actors:
DSB Ejendomme (owner of demolished building)
Cycle Superhighway Secretary (SCS)
Municipality of Copenhagen
Municipality of Gentofte

Potential partnership:
Veksø (bicycle rack provider)
Potential stakeholders: Renter "Trafikskolen" (demolished building)



[4] Odense Kommune, "Cykelparkering ved Odense banegård", presentation at Weinrich Mobility Seminar March 2018

HERLEV STATION AREA

- new connections

Herlev Station is located approximately 1 km from the suburban town center of Herlev. The station is close to the Ring 3 highway and the shopping center, BIG. The main square in front of the station is characterized by an adjacent car parking area and a bus terminal. There are two access points to the station, one is the main square at the front of the station, the other is slightly more hidden in the rear of the station located with access to an area with detached houses.

S-train lines: C H

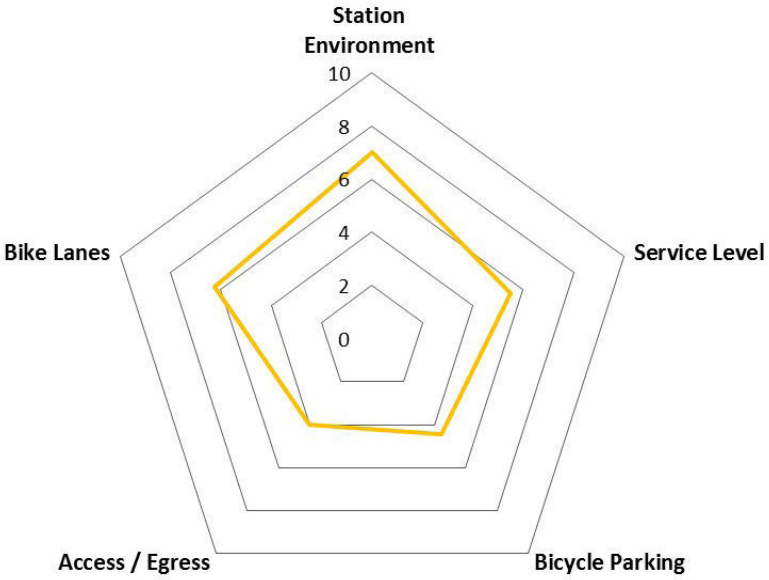
Bus lines: 155, 161, 165, 167, 168, 30E, 300S, 350S

Amount of bicycle parking: 1200

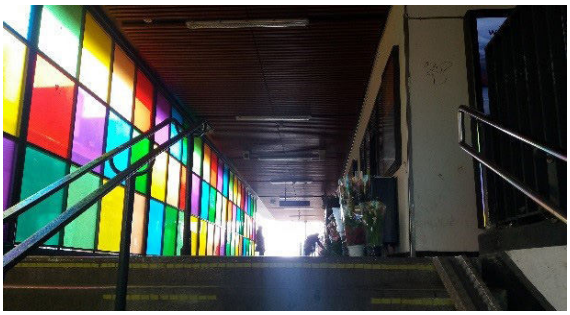
Bicycle parking occupancy rate: 45%

Train: 12.000 passengers a day

MAPPING OF THE CURRENT STATE

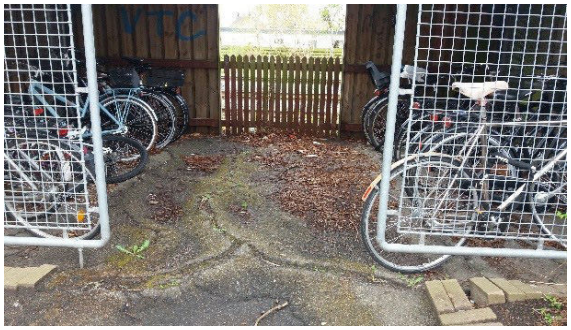


The station scores a decent grade on the station environment. It does so, because it is clean and tidy even though it is old, and it contains the basic conditions for waiting train and bus passengers. Furthermore, the station offers extra aesthetic details in the old station building, see picture 1. The area scores relatively high on bike lanes as well. A continuous bike lane, seen on picture 2, runs directly past the bicycle parking without any intersections or stops from the nearest Cycle Superhighway, which is located around 500 m away from the station. The station has a high number of bicycle parking spaces relative to its size, but almost half of them are poorly maintained as picture 3 show.



Picture 1: Special details in the station building

Picture 2: View of the bus terminal



Picture 3: Sheltred bicycle parking

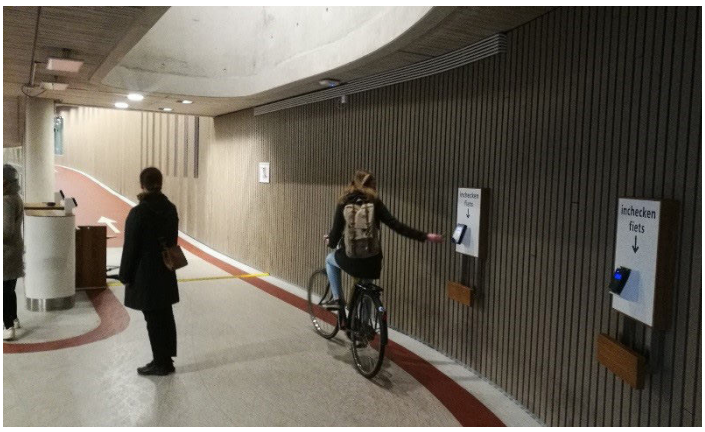
PONTENTIALS FOR SHORT TERM IMPROVEMENTS

The station area is dominated by destroyed, unused, and misplaced bicycles, see marked areas on the map. The access routes for bicyclists to the station are marked red on the map. It is interesting to notice, that the north access road leads directly to the entry point of the station (marked green), but it does not lead bicyclist to any parking area on the way. This means that the only way to the bicycle parking, is a detour for the cyclists arriving from the north of Herlev. The location of the bicycle parking does not meet the requirements of the bike-train users, as it disrupt the flow towards the train. The parking area, marked blue on the map, therefore have a very low occupancy rate of 13 %. The flow of the bicycle route result in an overcrowded front square that, if it were not for all the bikes parked outside of racks, would be a nice place to sit and wait.

The short term solutions to the above described problematic structures are to reconfigure the existing bike path, adding a lane, thus it becomes a two-way bike lane that will constitute a more direct route for cyclists to and from the station.

Picture 4: Two-way bicycle lane in The Netherlands

The station area suffers from negleted bicycle parking racks, bicycle sheds and many abandoned bicycles. We suggest a renovation of the existing parking facilities, a clean up and introducing a system that makes it possible to monitor whether the bicycles have been stationary for long periods. This could either be done by using a key chip to enter the bicycle facility, see picture 5, or by creating a parking fee for bicycles parked in more than 24 hours. The latter is a solution introduced in the Netherlands, where commuters check in when arriving to the station with a keycard. Manual maintainance and clean up of abandoned bicycles are another option. The municipality of Copenhagen spend approximately 2 million DKK a year on removal of abandoned bicycles, a task handled by 9 employees[1].



Picture 5: Smart and fast system to check while still sitting on the bike, in at the underground bicycle parking facility in Utrecht Centraal, The Netherlands.

Picture 6: Bicycle parking facility in England, where the commuter get access with a private chip.

[1] Københavns Kommune.2017. ”Til kamp mod herreløse cykler” posted 28.09.2017 at https://www.kk.dk/nyheder/til-kamp-mod-herreloese-cykler

In 2024 a new light rail connecting the suburban areas of Copenhagen is established. The coming light rail will have several stops in Herlev; one at the bridge on Ring 3 approximately 200 meters from the existing train station. The new light rail station at Herlev station is estimated to have 3.600 passengers each day, of which 7 % will arrive to the light rail station on bicycle[2]. The current plan is to move the train platform, closer to the bridge and the connection to the future light rail[3].
Unfortunately, the access point for cyclists is not considered in the plan. It is important to rethink the access routes for the cyclists, especially when they have to move across different levels, from the station area to the bridge with the light rail stop. The current connection from Ring 3, is seen on picture 7.

Picture 7: View from the brigde on Ring 3, where the future light rail will stop.

In order to ensure a flow for bike-train commuters when the light rail is established, it is important to connect the existing station area with the new stop. We suggest a bicycle bridge leading the bicyclist from the upper level at Ring 3 to the train station area at ground level to increase the flow and accessibility for bicyclist, see picture 8.

Potential actors:

Danish Rails (Banedanmark & DSB)
The Light Rail Company
The LOOP CITY cooperation
Herlev Municipality
Dissing Weitling Architecture (the architectural firm behind the Bicycle snake)

Picture 8: The Bicycle Snake in Copenhagen[4], ensures the flow of the cyclists when difference in levels.

[2] Hovedstadens Letbane. 2015. ” Koncept for stationspladser - December 2015”.
[3] Banedanmark. 2017. ” Beslutningsgrundlag-Opgradering Herlev Station”
[4] DISSING+WEITLING architecture. 2018 “The Bicycle Snake“ http://www.dw.dk/cykelslangen-bicycle-snake/

ISHØJ STATION AREA
- flow to and from station

Ishøj is located by the southern coastline of the Capital Region of Denmark. The station is a natural center of the suburban area of Ishøj and is directly connected to the shopping center, Ishøj Bycenter. In 2005 the station was rebuilt to create a direct connection with the shopping center[1]. The station front was renewed and the old 70's entrance was replaced with new building with a large glass facade.

S-train lines: A E

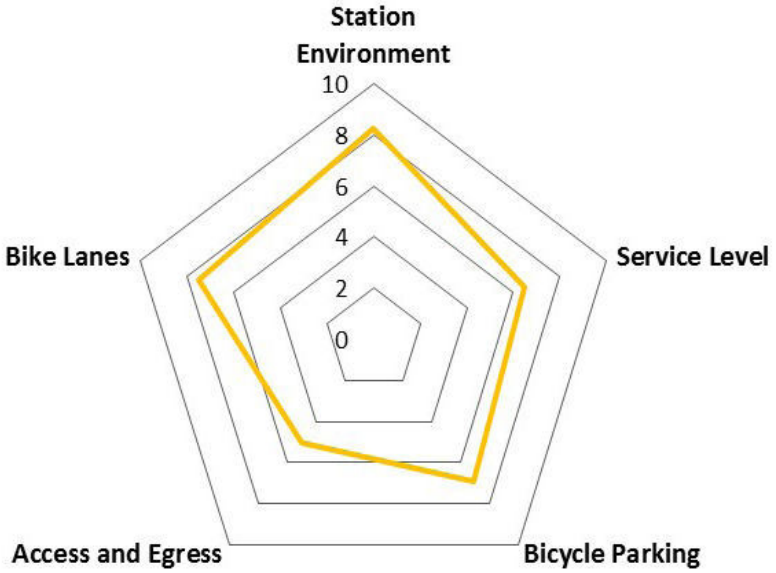
Bus lines: 127, 128, 400, 300S, 400S, 30E, 97N

Amount of bicycle parking: 550

Bicycle parking occupancy rate: 53%

Train: 12.000 passengers a day

MAPPING OF THE CURRENT STATE



Ishøj Station scores especially high on the parameter, *Station Environment*, which is consistent with an overall impression of a nice, clean and comfortable station, see picture 1, close to shopping facilities.
The bicycle infrastructure is directly connected to the station. Several entries to the station enable bicycle parking facilities adjacent to the platforms, see picture 2. Bicycle parking is placed by the stairs to the platform and is connected to a bike lane, separated from other traffic.
Several bicycle lanes run along the tracks and around the station area in green surroundings, see picture 3. Furthermore, tunnels under roads allow for a nice flow for cycling without stops and encountering heavy traffic.

1

Front square of the station and not a single bicycle parked outside the racks designated bike racks.

2

3

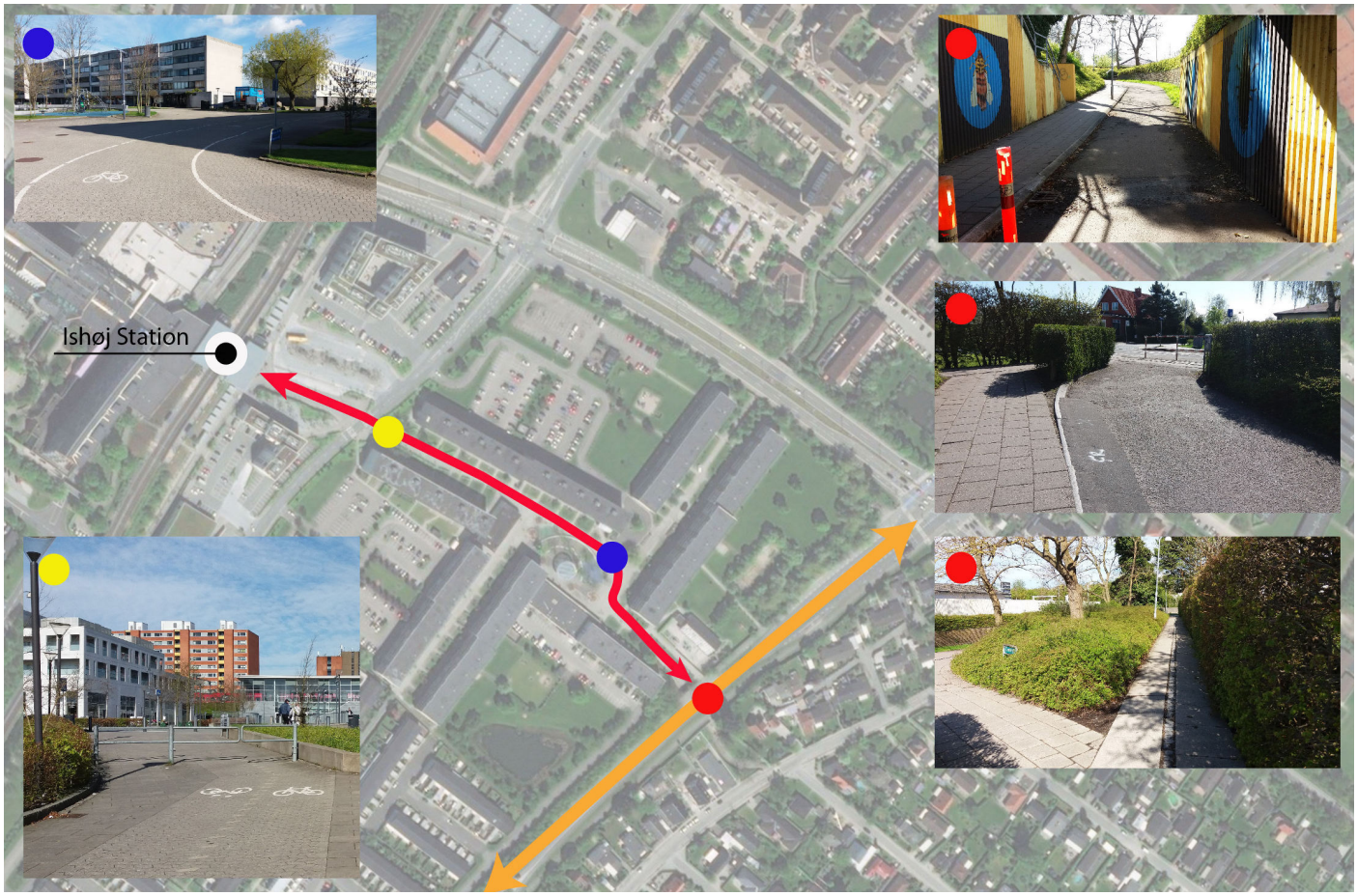
[1] Nielsen S., Møller M,2010 i Trafik og Veje 2010 http://asp.vejtid.dk/Artikler/2010/12/7785.pdf

PONTENTIALS FOR SHORT TERM IMPROVEMENTS

The overall standard for Ishøj Station is relatively high. However, the route connecting the station area with the Cycle Superhighway runs through a residential area and suffers under the impression that several different paths meet and overlap, which means that an overall flow and coherence is missing. The connecting route from the station to the Cycle Superhighway is marked red on the map below. In the map conflict points and barriers when cycling towards the Cycle Superhighway are visualized. Two places along the route, bars across the bike path stop the flow of cyclists. The pavement in the tunnel running beneath Ishøj Strandvej and the Cycle Superhighway is poorly maintained and there is little or no lighting on the route in general. We suggest that the first steps in improving the station for bike-train commuters are an upgrade of the connections to and from the station to the Cycle Superhighway.

At present moment the link between the station and the Cycle Superhighway is missing. However, the route marked in the map has potential as a good access and egress path for bike-train commuters cycling to and from Ishøj Station, as it is separated from heavy traffic.

Picture 3: Cycle Superhighway is marked orange and the route to and from Ishøj Station is marked red. The pictures relates to the specific location of the dots.



Ishøj Station is equipped with an underground bike path that runs beneath the station with artistic lighting details, see picture 4 below. This feature could be expanded and used to create a visual connection from the Cycle Superhighway to the station, see picture 6 and 7. This would contribute to a safer environment when cycling on the paths that runs through unlighted areas and furthermore it would help bike-train users to navigate to the station.

Navigation especially in unfamiliar surroundings can be a challenge for bike-train commuters, and may constitute a barrier to find an exciting and appropriate route, thus affecting the choice of cycling more.
Better wayfinding to and from the station is necessary, and could also be inspired by a less comprehensive design and use marks in the pavements as the Cycle Superhighway Secretary in Denmark, see picture 5.

Picture 4: Ishøj Station by night

Picture 5: Wayfinding in pavement at a Cycle Superhighway in the Capital Region of Denmark

Picture 6: The route in Ishøj connecting the station and the Cycle Superhighway

Picture 7: Cycle path In Poland, with solar cells that light up in the dark. Visibility and recognizability both day and evening.

Ishøj Station will be the southern end station for Ring 3 light rail, which is scheduled to open in 2024. It will generate approximately 1900 new passengers a day at Ishøj Station[1]. This will influence the conditions both on and around Ishøj Station, as the station will receive more interchanging passengers. Currently, 9% of all passengers of Ishøj station arrive by bicycle[2]. This is relatively low, which means there is potential for growth for the bike-train mode on this particular station.

In a long term perspective, it could be beneficial to consider establishing a station bike scheme at Ishøj Station, as it will be the southern terminus of the light rail. This could either be done by expanding the operational area of the CityBike (Bycyklen) to include the area where the light rail runs, or by establishing an entirely new scheme. This would give the passengers whose destination is in the Ishøj area a good last mile option which would increase their flexibility. Furthermore, it should be considered if it should be allowed to bring the bicycle along in the light rail for free, even during rush hour. These two initiatives would greatly benefit the bike-train mode and make it even more competitive to commuting by car.

Picture 8: OV-fiets rental scheme in Utrecht Central, the Netherlands

Picture 9: Bicycle along for the ride in the Aarhus

Potential actors:
DSB
Ishøj Municipality
Bycyklen
The Capital Light Rail

Potential partnerships:
Donkey Republic

[1] Hovedstadens Letbane. 2015. "Koncept for stationspladser December 2015"
[2] Urban Creators. 2018. "Fremtidens kollektive transportknudepunkter i hovedstadsområdet – del 1." Urban Creators

LYNGBY STATION AREA

- accessibility of station

Lyngby Station is one of the major traffic nodes in the Capital Region of Denmark. With S-train line operating and a comprehensive bus service many commuters arrive by car, bicycle and on foot. Lyngby Omfartsvej runs above the station building and the freeway connecting the city Lyngby with the capital and northern Zealand. An adjoining shopping arcade forms a shopping environment from the station square to the main shopping street in the city center.

S-train lines: E B

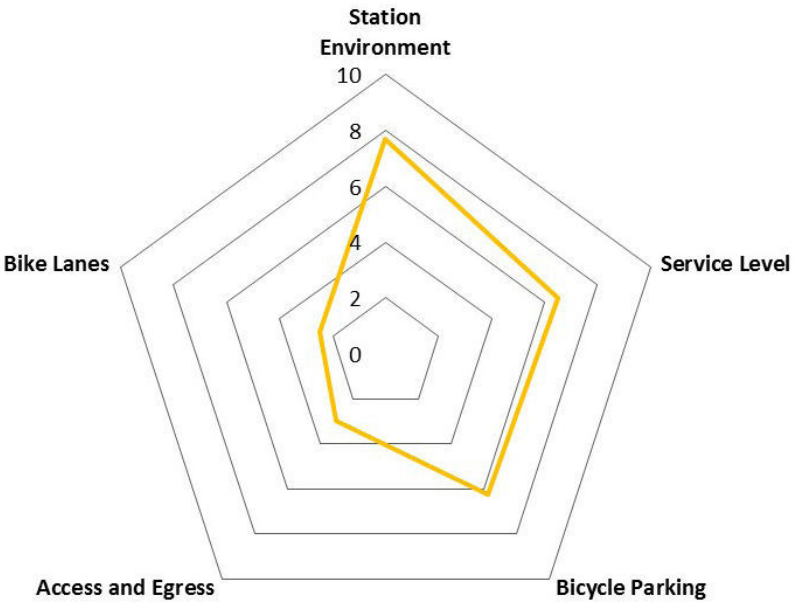
Bus lines: 161, 169, 170, 179, 180, 181, 182, 183, 184, 190, 191, 192, 194, 388, 400, 300S, 400S, 94N

Amount of bicycle parking: 1615

Bicycle parking occupancy rate: 44%

Train: 27.200 passenger a day

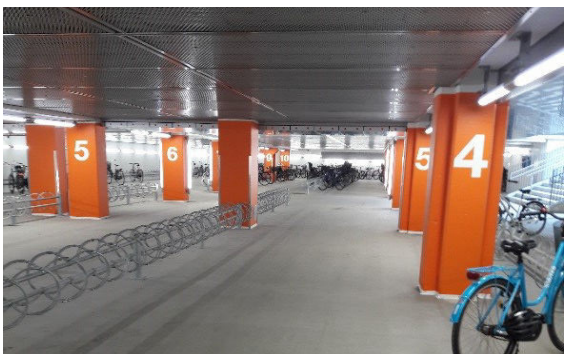
MAPPING OF THE CURRENT STATE



The nearby shopping opportunities and a recent upgrade of the station area[1] give the station a high score in station environment and services, see picture 1. Lyngby Station scores significantly lower on parameters such as bike lanes and access conditions to the station and to the platforms. The bike lanes in the area are close to none existent, and do not meet the requirements for a good bike path. Overall, the bicycle infrastructure to and from the station is characterized by a low quality, as the cyclists must share the road with cars, see picture 2. Despite a new underground bicycle parking facility, see picture 3, the station only scores 5/10 in bicycle parking due to accessibility issues.

Picture 1: The entrance to the station area

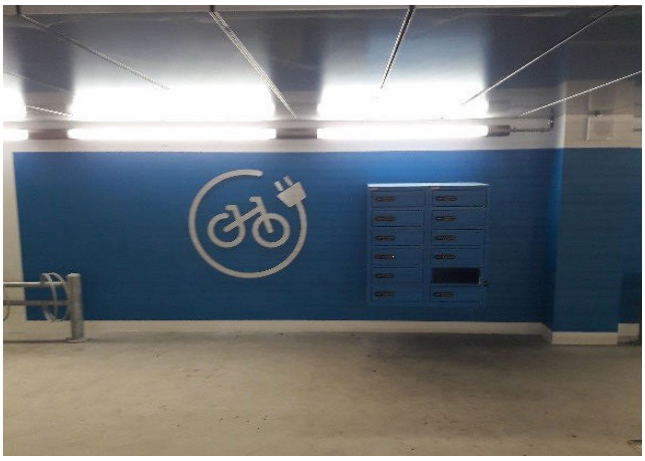
Picture 2: Road shared between cars and bicycles



Picture 3: new bicycle parking facility

[1] Gottlieb Paludan Architects, n.d. "Lyngby station" at http://www.gottliebpaludan.com/en/project/lyngby-station.

In March 2018, a new underground bicycle facility with room for 860 bicycles, opened at the station. The facility has two access points and is equipped with camera surveillance, a specially designed light fixture with strong light and high classical music, and locked cabinets for charging electric bikes, see picture below.



However, there is no room for cargo bikes, or other special bikes.
Unfortunately, the entrance to the bicycle parking is completely hidden away, see picture 5, and inaccessible as the only access route to the new bicycle parking is a road shared between cars, trucks delivering goods to the shops located in the station building, taxis, kiss'n'ride and cyclists, see picture below. These structures are problematic for the bike-train user as they hinder a continuous flow when accessing or egressing the station.

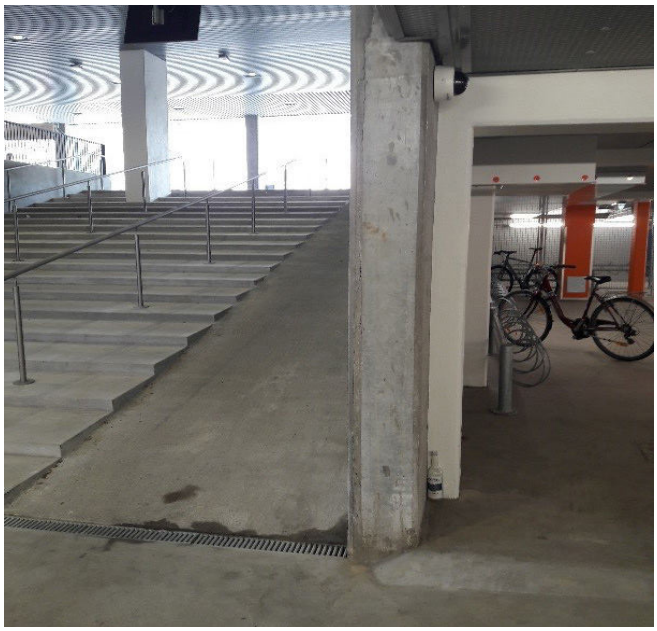
Picture 6: Shared road between bikes, cars, taxis, delivery trucks in front of Lyngby Station.

We therefore suggest creating a bicycle priority route and closing the street running past the parking facility for cars. Instead a flexible delivery system could be introduced so the shops got delivered goods outside of rush hour leaving room for bike-train users during the day. The current occupancy rate in the new bicycle parking facility is 17 %.

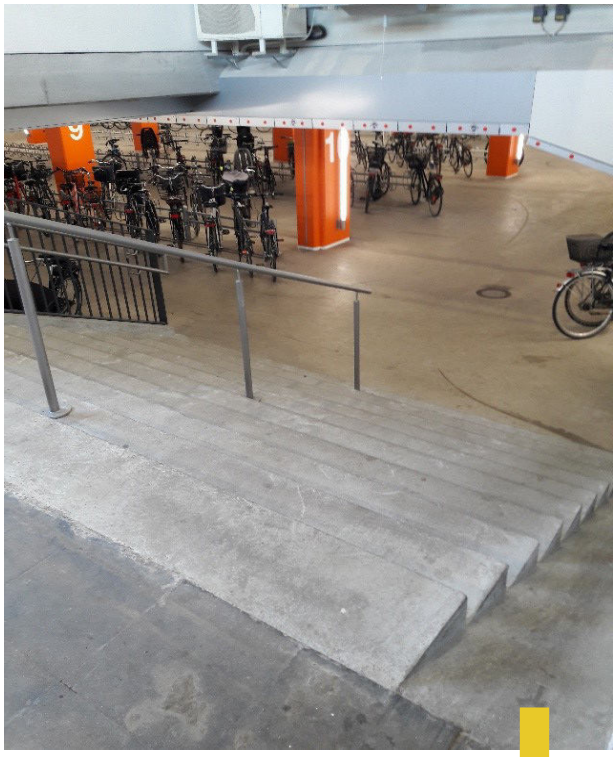
Picture 5: The entrance to the newly build bicycle parking facility

A way of making bicyclists aware of the parking facility could be done by introducing a signage system from different entrance points by the station area with signs guiding the bike-train user towards the unoccupied parking spaces. Bicycle parking guidance system in Utrecht, the Netherlands seen on the picture below.

It is worth noting that both descents to the parking facility consist of stairs or narrow areas where cyclists can pull the bike up and down, see picture 7 and 8. Here, there is no room for traffic in both directions at the same time, which can be a major frustration factor for travelers in rush hour. We suggest a short-term solution placing electronic ramps on the stairs for pulling the bikes up and down, or to decrease the wide stairs and make the part where a bicycle can be walked down broader, see picture 9.



Picture 7: Main entrance to the bicycle facility in Lyngby



Picture 8: Second entry point closer to the platforms at the bicycle facility in Lyngby

Picture 9: Electronic ramp system in underground bicycle facility, Utrecht, The Netherlands.

LONG TERM RECOMMENDATION AND SYNERGIES WITH OTHER PROJECTS

Lyngby station will be a future end station of the coming light rail planned to cross the suburbs in the Capital Region of Copenhagen. The establishment of the light rail along the freeway Ring 3 will cause a reduction in the number of bus lines serving the station, but the area is still expected to have an increase in passengers and many transfers between different modes of transport.

The light rail will result in 4.700 more travelers per day[2], of which 14% is estimated to arrive at the station by bicycle[3]. The light rail will cross the main shopping street, Lyngby Hovedgade, and the Cycle Superhighway. We suggest a reconfiguration of the entire square in front of the station and the creation of bicycle lanes running straight into the parking facility thereby ensuring the flow of the bicyclists, see picture 10 and 11.

Picture 10: The entrance to the newly build bicycle parking facility

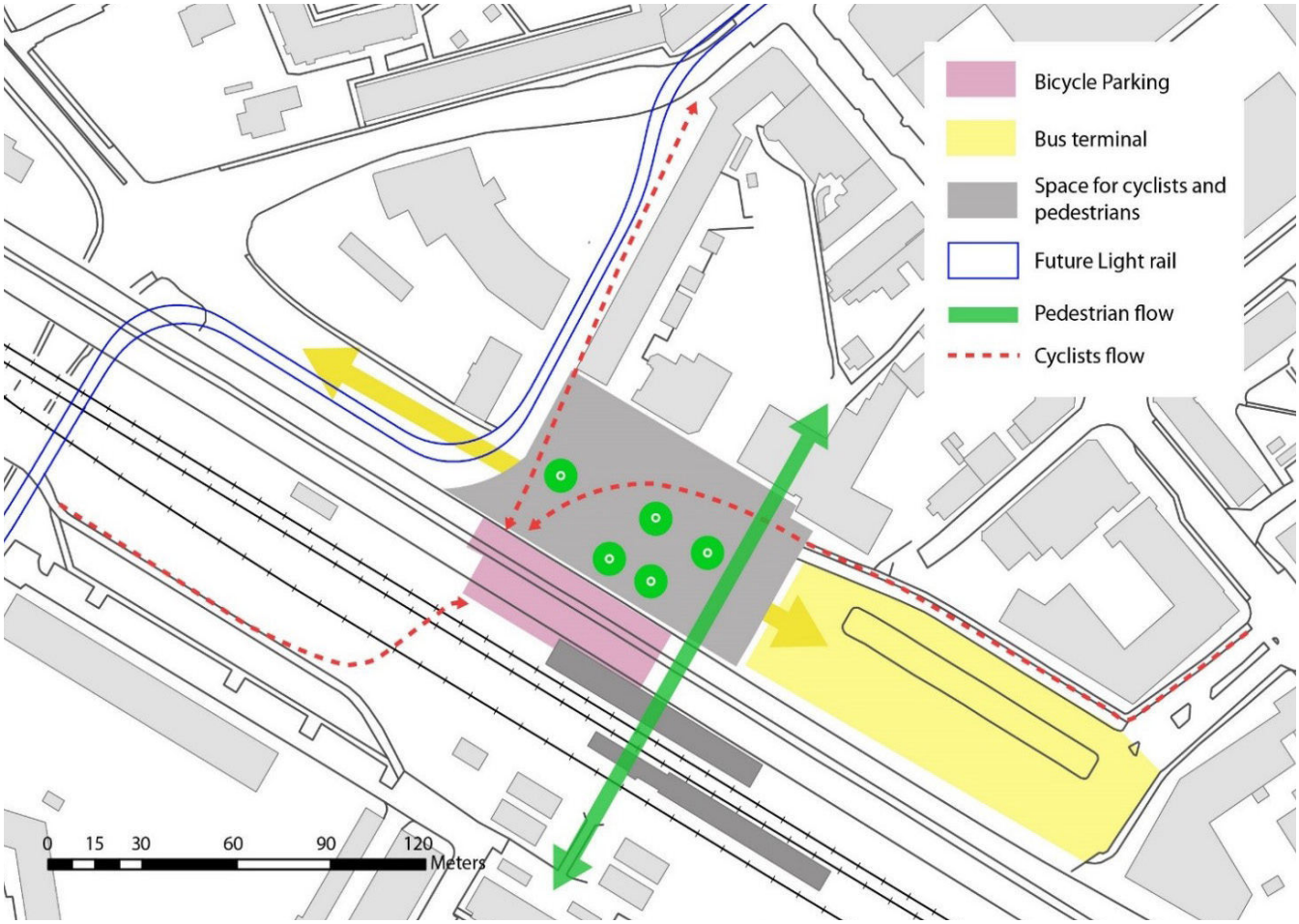
Picture 11: The entrance to the newly build bicycle parking facility

[1] Udredning om Letbane på ring 3, Ringby-samarbejdet, 2013
[2] Hovedstadens Letbane 2015, Koncept for stationspladser

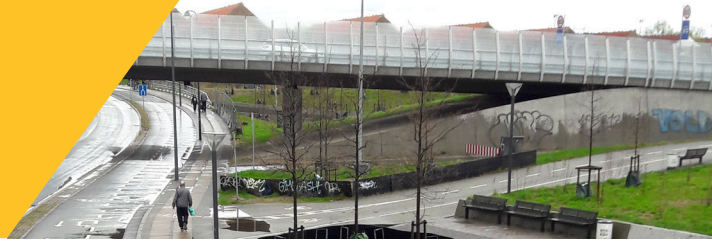
We suggest a long-term plan for the station, where the front of the station, Jernbanepladsen, which today is characterized by all forms of traffic, is completely restructured. The grey area, marked on the map, forms a new inviting square for only bicyclists and pedestrians with good waiting facilities for both passengers of the light rail and busses. Busses are led under the square in a tunnel re-emerging the same place as the current bus terminal. New bicycle routes are created in the side streets to the station area. Today, it is only possible to access one of the two platforms from the bicycle parking, which makes it difficult to shift modes and increases travel. We therefore suggest an expansion of the underground bicycle parking with a tunnel beneath the tracks that ensures direct access to all of the platforms. This expansion would also make it possible to link the bike path on the backside of the station to the new bicycle parking, see map.

Potential actors:
Danish rails (DSB Ejendomme)
Movia (bus company)
Lyngby-Taarbæk Municipality

Potential stakeholders:
Business community at Jernbanepladsen



RYPARKEN STATION AREA
- improving service level



Ryparken Station is located in the eastern part of Copenhagen. The station is placed in a central traffic node and cross the highway from Lyngby and the freeway to northern Sealand. The station area is therefore marked by heavy traffic and does not invite to urban life. The station was upgraded in 2015 and the architectural details from the 70's have been reconstructed[1]. Along the train tracks and close to the station is numerous sports club located with adjoining outdoor fields.

S-train lines: A F Bx

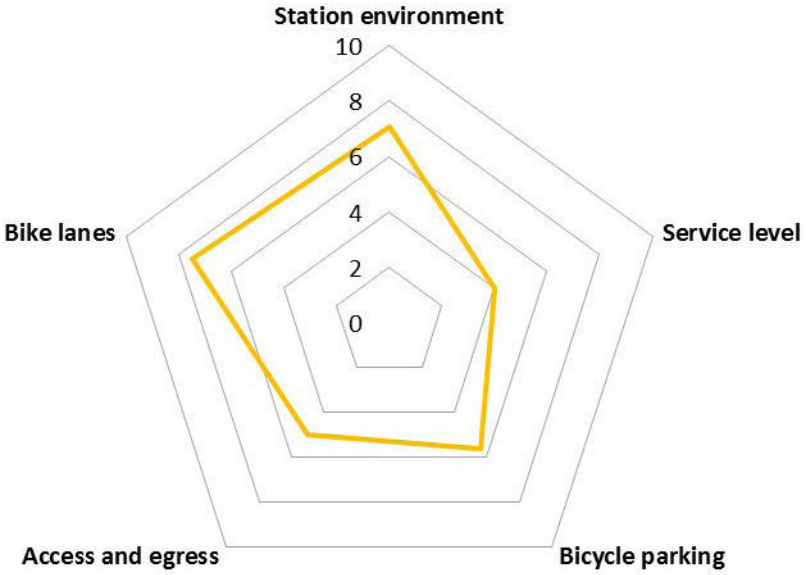
Bus lines: 14, 184, 185, 150S, 15E, 94N

Amount of bicycle parking: 422

Bicycle parking occupancy rate: 72%

Train: 10.400 passengers a day

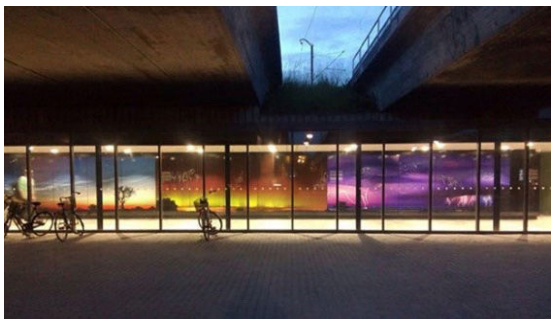
MAPPING OF THE CURRENT STATE



The station is well connected with quality bike lanes. The Cycle Superhighway to Allerød, see picture 1, and the green bicycle route Nørrebroruten runs right by the station. The upgrade of the station in 2015 include installations of lighting and art which increase the sense of safety and the station environment in general, see picture 2. The new bicycle parking with a characteristic red gravel as pavement seems to invite the commuters to park in that zone and the number of bikes outside of the rack is low, see picture 3.
Cars, however, dominate the space around the station, and this seems to influence the service level of the station. The area does not invite to urban life and services such as bicycle repair and shopping opportunities are therefore absent.

1

2

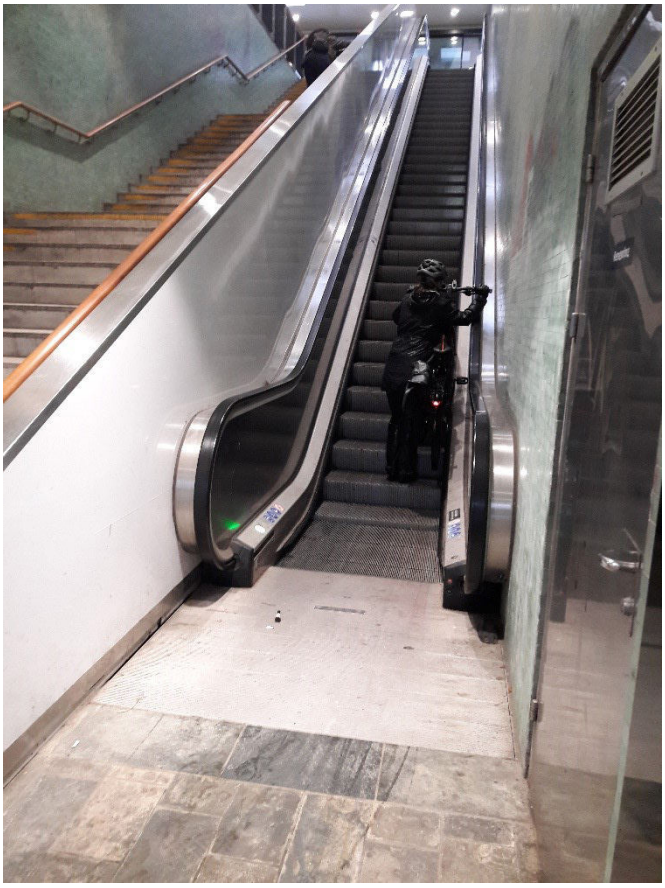


3

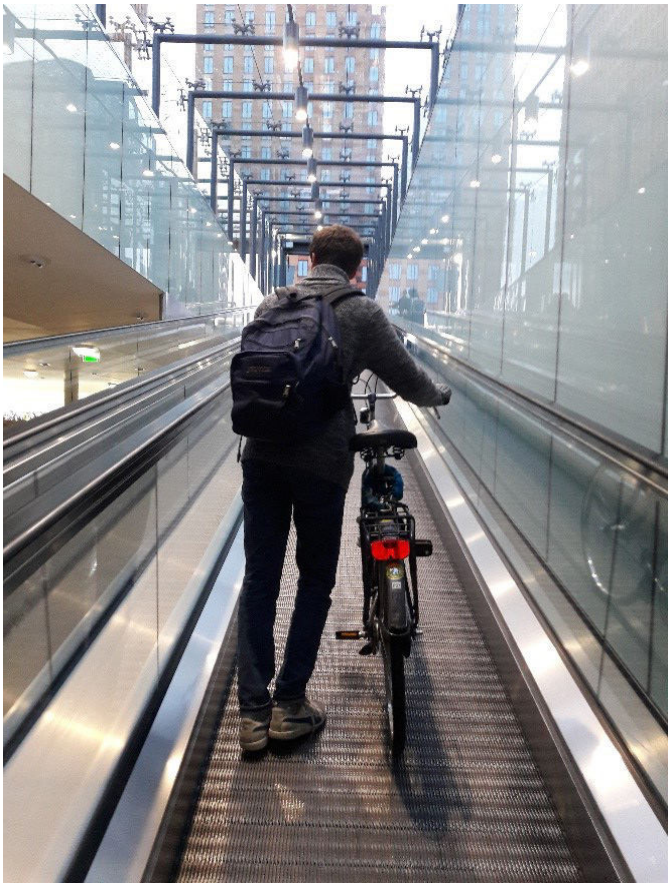
[1] Gottlieb Paludan Architects. n.d."Ryparken Station, Renovering og modernisering" at http://www.gottliebpaludan.com/da/project/ryparken-station-0

The strenght of the station area is the direct connection with the Cycle Superhighway. This creates a possibility of a countinues flow for the bike-train commuters. Observations at the station revealed that commuters biked the entire way to the parking facility or to the stairs leading to the platforms, see picture 4. The flow can however be improved by lowering the curb from the bicycle path or by installing bike-friendly escalators to the platform se pictures 5 and 6.

Picture 4: Observed desirelines from the Cycle Superhighway across the entrance square at Ryparken station

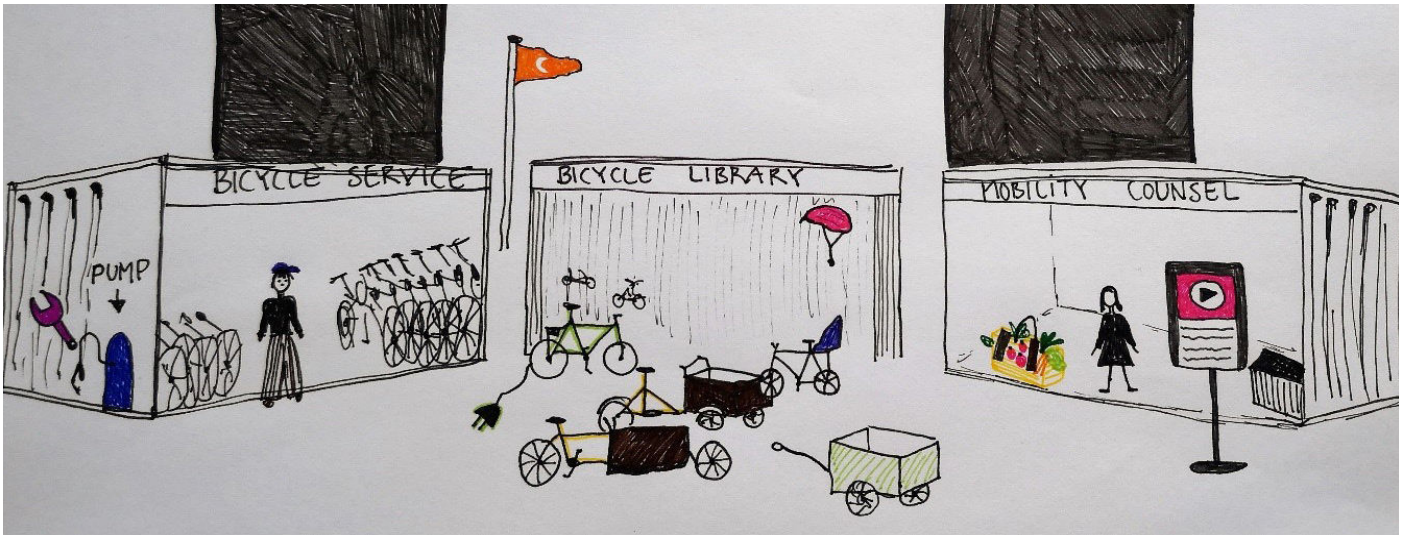


Picture 5: Escalator to the platform at Ryparken Station



Picture 6: Bike-friendly escalator in Amsterdam Zuid

The service level at the station is low with no shops at the station and few functions in the adjacent area. This is highly problematic as the service level of the station can improve the waiting time and ensure that the commuter have time to fulfill the variety of other obligations of everyday life on the way to or from work. The station services should create more flexibility in the everyday life of the user and improve the conditions of bike-train commuting. At stations such as Ryparken with a low service level and no available buildings where services can be provided a more mobile solution might be considered. We suggest pop-up services in containers ect. where different services can improve the bike-train commute, see sketch below of square in front of station entry.



Picture above: sketch of pop up services at Ryparken station. **Pictures below:** top left: Pop up repair in New York. top right: Bike rental in New Zealand. bottom left: Shimano show case. bottom right: Bicycle innovation lab Copenhagen.

LONG TERM RECOMMENDATION AND SYNERGIES WITH OTHER PROJECTS

40 station bicycles are placed at Ryparken station by the provider Bycyklen. The vision behind the station bike scheme was to be “the fourth pillar” supplementing bus, metro and trains in the city of Copenhagen[2]. The bike share system connects 46 stations in the city, but does not reach beyond the border of Copenhagen. However, to create a flexible bike-train mode the station bike system of today needs to be reconfigured. Different errands to or from work can be a barrier for commuting by bike-train. Therefore, we suggest further development of the bike sharing system making it able to facilitate the concept of “a bike for every situation”. The daily needs of the commuter change; one day you might have to pick up your children and need a cargo bike, another day the weather is nice and you want to get some exercise on a racing bike. Sometimes you might need an electric bike when travelling long distances and at other times you might need to bring a folding bike with you on the train. The bike-train service system at future stations is proposed to be composed of 3 different concepts, see below.

Mobility counsel:

1) Show case room and help to home-delivery services to ease the responsibility of daily obligations

2) Inspirational videos where intermodal ambassador share their experiences to increase bike-train competences

3) Mobility counseling to routes, ticket savings etc. to increase bike-train competences

4) Map of the bicycle routes in the area to increase bike-train commuters navigating skills

Quality station bike service:

1) A variety of bikes; racing bikes, cargo bikes, children bikes, folding bikes, city bikes and e-bikes

2) A variety of equipment and gear; children seats, rain poncho, bicycle bag, bicycle lights, bicycle helmets, bicycle clothes ect.

3) Easy check in and check out of the bikes (manned service)

4) A flexible subscription so you can shift between bikes from day to day

5) A chance to test out different types of bikes

Bicycle repair:

1) Maintenance of the stations bikes

2) An around the clock call out service/subscription for bicycle repair

3) Repair while away to work (using repair cards/booking system)

4) Help to do it yourself repair outside of opening hours

Picture 7: Check in of stations bikes in bicycle parking facility in Utrecht

Picture 8: Repair service slip to put on bike at bicycle parking in Utrecht, the bike is repaired while owner is away

[2] Bycyklen. n.d. ”Facts om bycykelsystemet”, at https://bycyklen.dk/da/om-os/facts-om-bycykelsystemet/

Potential actors:
Train operator (DSB)
Cycle Superhighway Secretary (CSS)
Municipality of Copenhagen

Potential partnerships:
Delivery services (Nemlig.com)
Bicycle sharing systems/library (The Bicycle Innovation Lab)
Repair service (Cykelven)
Mobility consultancy (Rejseplanen, DOT Pendlertjek)

VALBY STATION AREA

- prioritized bicycle infrastructure

Valby Station is currently the 5th largest station in Denmark measured on passengers a day[1].
The station is wedged in between residential and commercial buildings in a dense neighborhood. The station is more than a 100 years old and the neighborhood of Valby have evolved around it. The station is located right by the shopping center Spinderiet.

Train lines: REGIONAL InterCity

S-train lines: H C B Bx

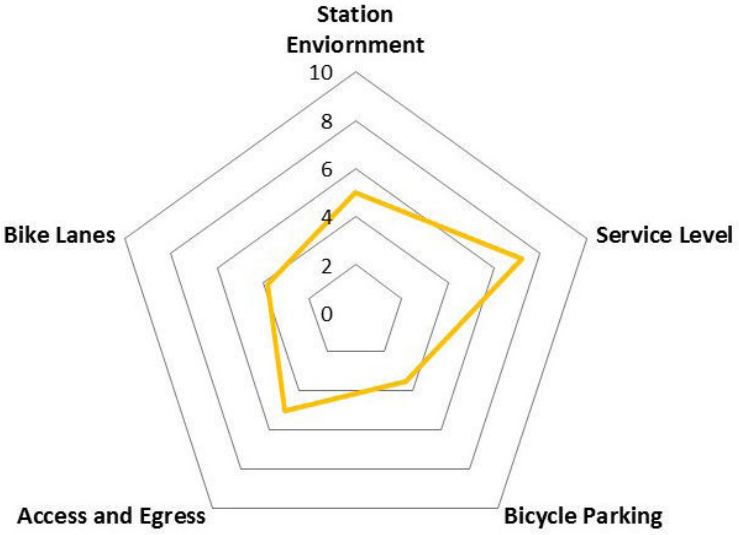
Bus lines: 132, 133, 4A, 8A, 888

Amount of bicycle parking: 1157

Bicycle parking occupancy rate: 71%

Train: 31.400 passengers a day

MAPPING OF THE CURRENT STATE



Due to the densely populated area where the station is located, access to and from the station by bicycle during rush hour can be chaotic and an unpleasant experience. All of the access roads to the station are mixed traffic, with no bike lanes, see picture 1. Overall, much of the infrastructure and station environment is not on par with the status of being the 5th busiest station in Denmark. The station area has low scores on 4 out of 5 parameters. The reason for the low score in *Station Environment* is due to lack of maintenance in the station area. Unpleasant smells, graffiti and trash are dominant in large parts of the station area, especially in the access tunnel, the southern entrance to the station building and the remotely located locked bicycle parking on the northern side. Furthermore, the station scores low in *Bicycle Parking* as the most convenient parking spaces are fully occupied, causing capacity problems. Many of bike racks of the station are of low quality and are worn down, see picture 2.

1

The road to bicycle parking and station entry on the south side of the rails is shared with busses and taxi drop of/pick up zones

2

Sheltered parking with insufficient lighting and low occupancy rate in the “back” of the station.

[1] Trafik- Bygge- & Boligstyrelsen. 2017. ” Trafikplan for den statslige jernbane 2017-2032”

PONTENTIALS FOR SHORT TERM IMPROVEMENTS

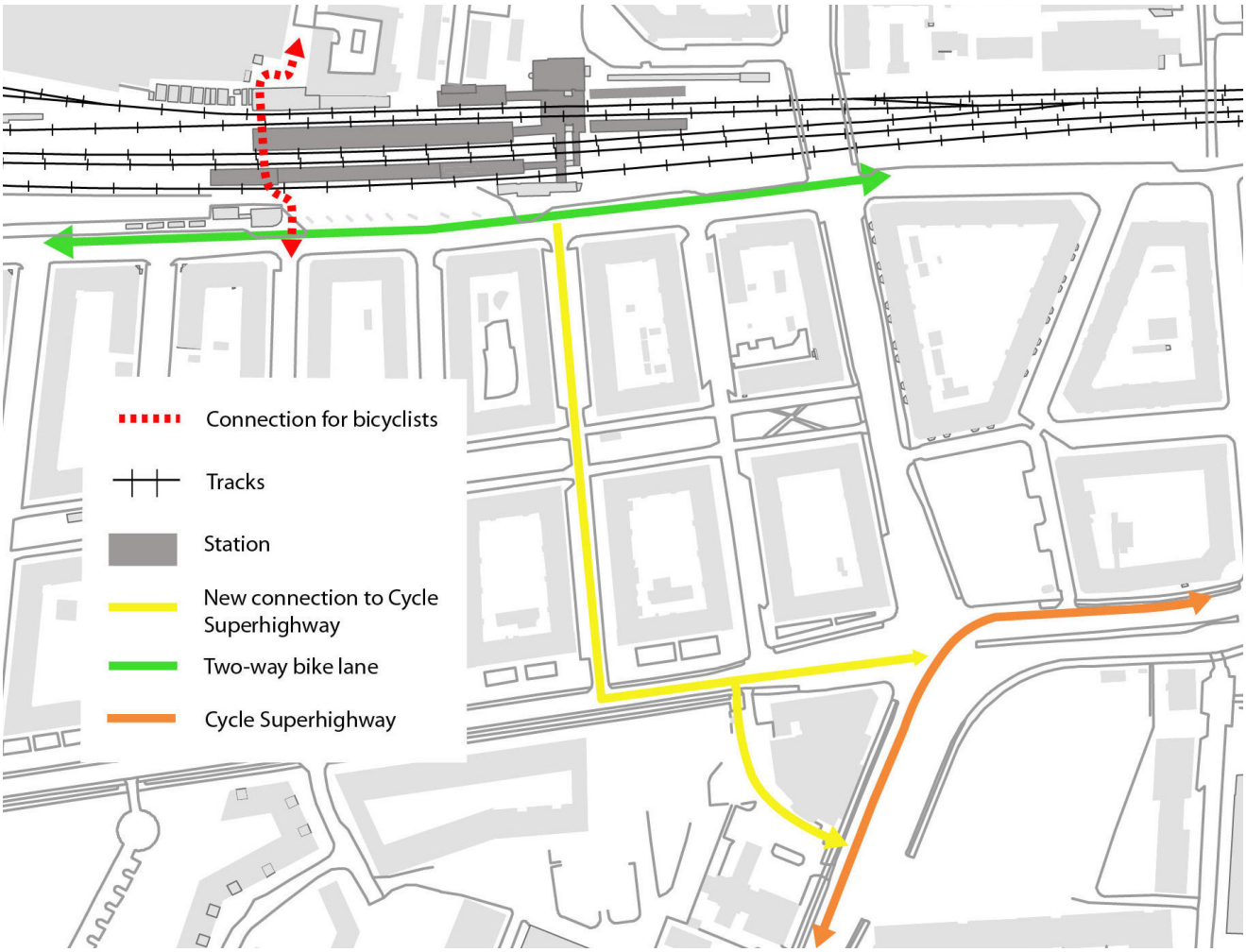
To realize Flintholm stations potential, it is necessary to establish more and better connections to the Cycle Superhighway, two such connections are presented in the map, next page. We suggest to make one regular connection and one green connection, as it is found that the combination travelers have different preferences that shift on a day to day basis. To improve these two connections, some problematic structures needs to be addressed.

Picture 3: limited width of bicycle lane on bridge, the main entry point when arriving from the districts Sydhavn, Vesterbro and the Municipality of Hvidovre.

To improve the access to the station by bike it will be necessary to establish more bike lanes in the catchment area. We suggest moving the taxi drop of zone and establish a two-way bicycle lane down Lyshøjgårdsvej, to provide a safer and more convenient access to the station for bicyclists, see picture 4 and 5 below and green line on the map.

Picture 4: One of three main access roads to Valby station, Lyshøjgårdsvej

Picture 5: Two-way bicycle path in Brooklyn, New York

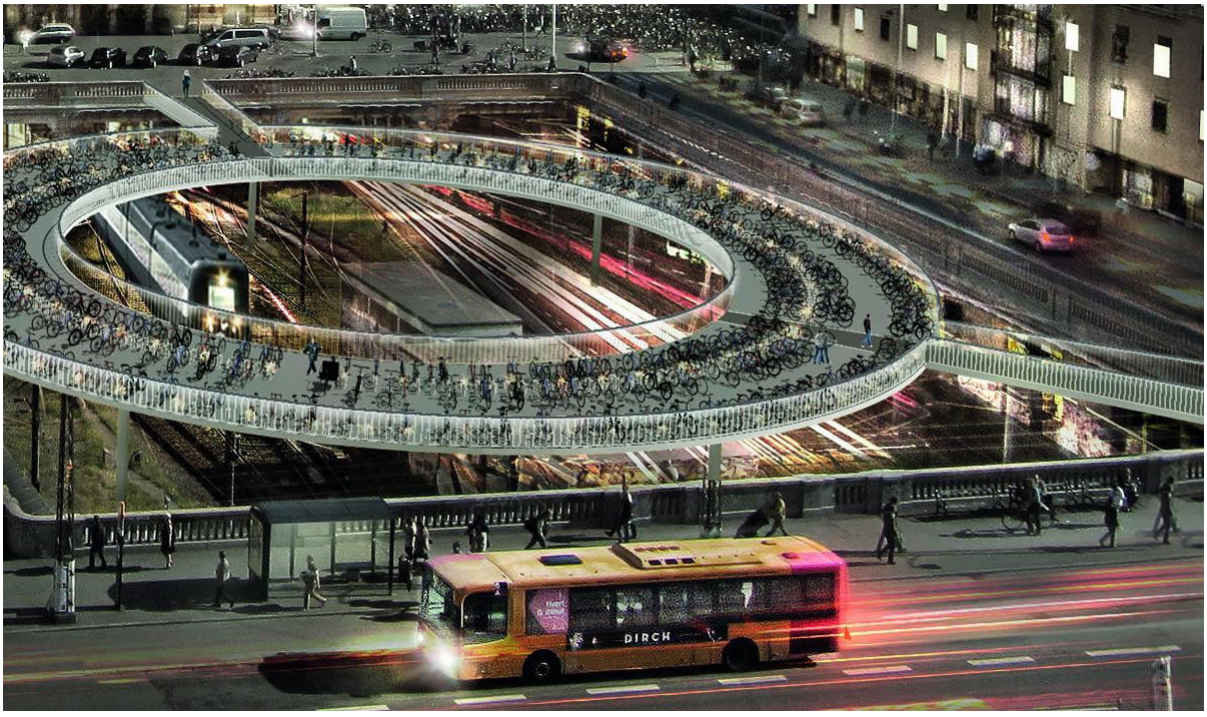


To improve the access to the station by bike it will be necessary to establish more bike lanes in the catchment area. We suggest moving the taxi drop of zone and establish a two-way bicycle lane down Lyshøjgårdsvej, to provide a safer and more convenient access to the station for bicyclists, see picture 6 and 7 and green line on the map.

Picture 6: Residential side street to the station area of Valby by the south entrance, Overskousvej.

Picture 7: Bicycle priority street in Utrecht, The Netherlands

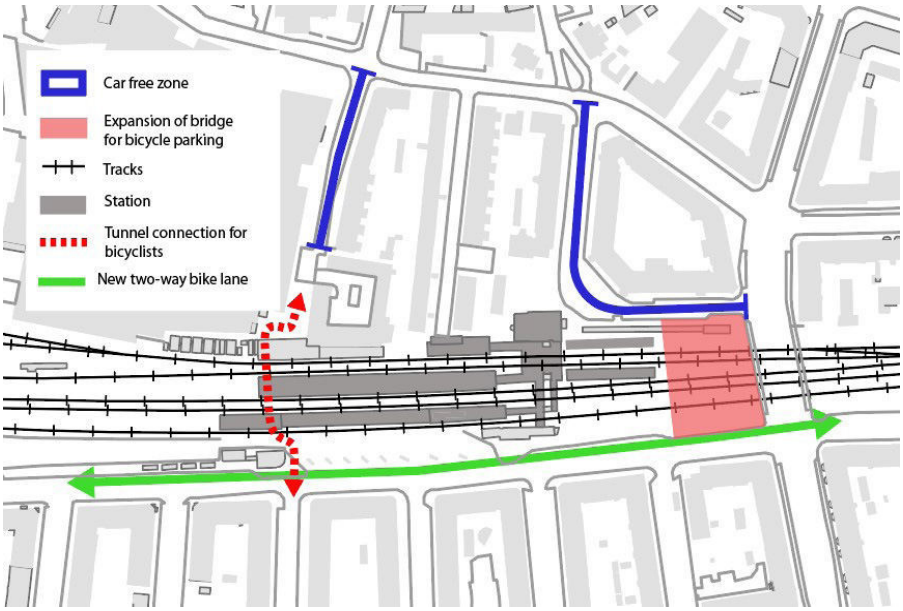
As of now, Valby Station have bicycle parking facilities to cover 4.6% of the 26.000 daily users of the station. This is troublesome as an average of 27% of the commuters in the capital region arrive to the station by bicycle. Due to the high density around Valby Station, it is assumed that the share of commuters arriving on foot is higher than the regional average. However, the current amount of bicycle parking does seem inadequate in a scenario where the bike-train mode is growing. The municipality of Copenhagen predict that a total of an extra 1000 parking spaces is needed in 2025. Currently 400 extra bicycle parking racks are being built[2]. If Valby were to be compared to the Dutch city of Utrecht where 46% arrive to the station by bicycle and 30.000 bicycle parking racks service 176.000 passengers per day[3] around 4400 parking racks should be build. These numbers are speculative, and only serve to put the current parking situation into perspective, but, it highlights the necessity for radical action.
Valby station is located in a dense area and to find space for future bicycle parking is difficult. At the same time the station of Valby is worn down, badly lit and is unappealing to the senses. The process of designing new areas for bicycle parking should therefore also benefit and lift the general station environment as well. The platforms at the station are lowered and one solution could be to cover the tracks up by the bridge, creating a new and impressive space for parking, see picture 8 below.



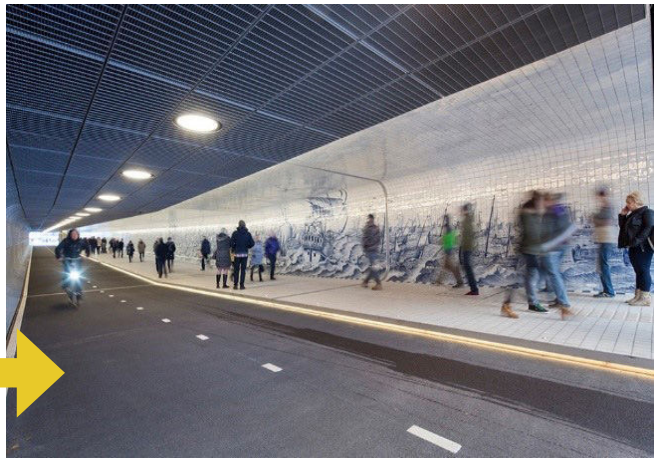
Picture 8: Visualization of possible future bicycle facility at the central station in Copenhagen.

[2] Teknik & Miljøforvaltning. 2018. ”Prioriteringsplan for cykelplan”.
[3] Treinreiziger. 2015. ”Aantal in- en uitstappers per station” at https://www.treinreiziger.nl/aantal-in--en-uitstappers-per-station/ and Interview Liu and Te Brommelstöet

Extra bicycle parking could also be found in the adjacent streets to the station if the roads were closed down for cars, see blue lines on the map below. The closure of the two streets could also enhance the flow and accessibility of the station for bicyclists. Expanding the tunnel running under the tracks for bicyclists would increase the attraction of the new bicycle access points and decrease the congestion of passengers on the bridge, see pictures below.



Picture 9: Tunnel under the tracks at Valby Station



Picture 10: Bicycle tunnel in Amsterdam Central

Picture 11: Access route with high concentration of parked bikes, Skolegade at Valby station

Picture 12: Pedestrian and bicycle street in Amsterdam

VANLØSE STATION AREA

- access to bicycle parking

The station is located at Vanløse Torv on Jernbane Allé, which is the main shopping street of the city district Vanløse. The largest square at the station entry is directly connected to the newly-built shopping mall Kronen. The area surrounding the station is a mixture residential apartments and family houses. Vanløse is an outer city district of Copenhagen and the end station of the metro network. The catchment area of Vanløse Station include suburban areas in the adjacent municipalities.

S-train lines: C H

Metro lines: M1 M2

Bus lines: 10, 13, 22, 31, 142, 9A

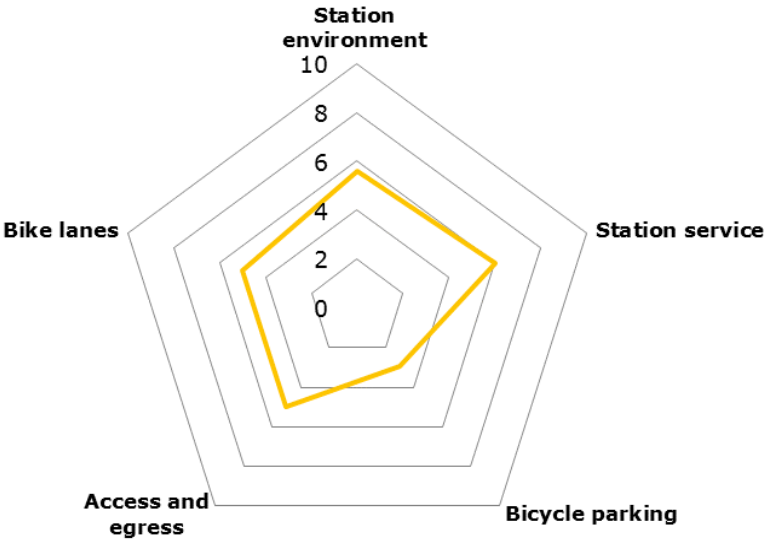
Amount of bicycle parking: 1306

Bicycle parking occupancy rate: 77%

Metro: 11.315 passengers a day

Train: 17.500 passengers a day

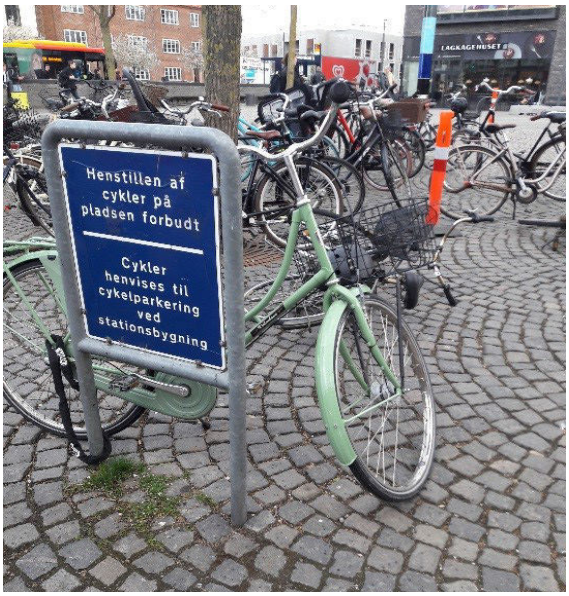
MAPPING OF THE CURRENT STATE



1

The diagram shows that the station area scores low on bicycle parking conditions and access to these despite a new parking facility. Recently, a bicycle parking facility in two stories has been built, with direct access from the bicycle parking to the shopping center Kronen. Especially the missing connection between the parking facility, see picture 1, and modes of transportation, e.g. Metro and S-train from the parking facility is problematic. Furthermore, the station suffers from overcrowding parking areas and bicycles outside of designated bike racks, see picture 2.

2



PONTENTIALS FOR SHORT TERM IMPROVEMENTS

Vanløse Station only have two access points to the platforms; the big sqaure, see picture 3, and the small square on the other side of the tracks, see picture 5 (next page). The new parking facility have room for more than a 1000 parked bikes but only 47 % of the facility is occupied during working hours. 30 % of all the parked bikes at the station is parked outside of the bicycle racks. The cluster of misplaced bikes is located on the two sqaures.

Picture 4: Signage in pavement leading to underground parking facility, Amsterdam Zuid, The Netherlands. A square with shared space between pedestrians and bicyclists which is transferable to the conditions at Vanløse Station.

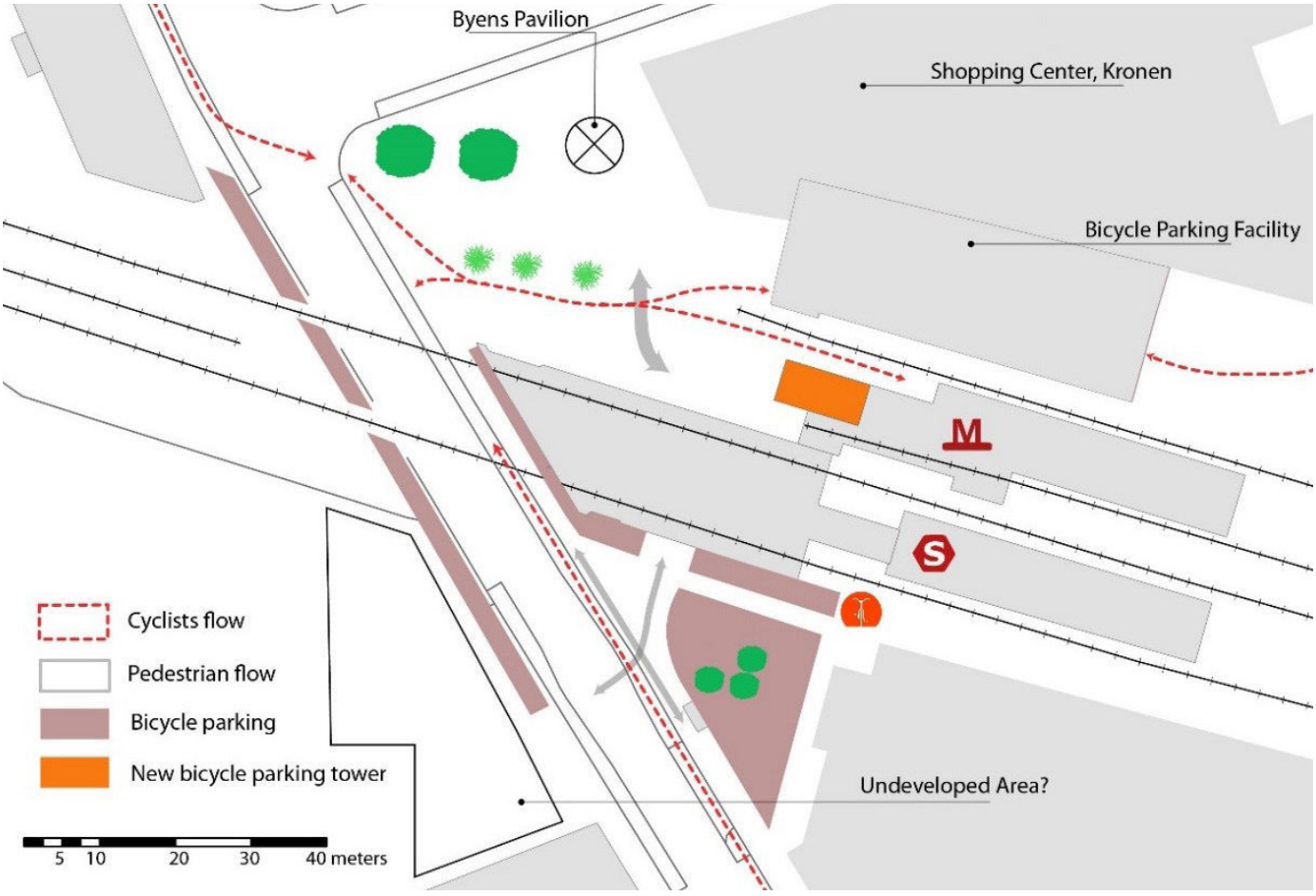
Picture 3: The access point to the bicycle parking facility is the big square at Vanløse station.

Picture 5 & 6: The small square at Vanløse Station. The area has a bike parking occypancy rate at 198 %. The majority of the square are fences off to ensure outdoor serving for the small café “Byens Pavillion”.

The new bicycle parking facility in two storages is close to the station but disconnected from the platforms and the bicycle paths running past the station. An initial solution could be creating access and egress routes to the facility. This might be done by creating multiple entry points to the facility; such as a bicycle path running east along the tracks on the backside of the station, see map below. At the same time it is essential to ensure the flow from the current bicycle route at Jernbane Allé to the facility; such as signage in the pavement and a prioritized path over the big square, see picture 3 and 4. We also suggest moving the café Byens Pavilion from the small square to the bigger square in front of Kronen.

That way more bicycle parking can be created in the problematic area on the small square, see map. Vanløse station is one of the only stations in Copenhagen that does not have access to the station bike system “Bycycklen”. A future upgrade of the parking areas at the station should make room for the service.

On the map, possible future locations for more bicycle parking have been marked. A new local plan might impose more bicycle parking at an undeveloped area across from the small square at the station. Or the empty building at the metro station entry might be used for future bicycle facilities (orange area on map).



LONG TERM RECOMMENDATION AND SYNERGIES WITH OTHER PROJECTS

The Municipality of Copenhagen estimates an increase in the need for bicycle parking of approximately 3500 spaces in 2025 at Vanløse Station[1]. Against this backdrop and the conducted observations at the station, the focus must be on ensuring full utilization of the existing parking facility as well as consider possibilities for expanding capacity.

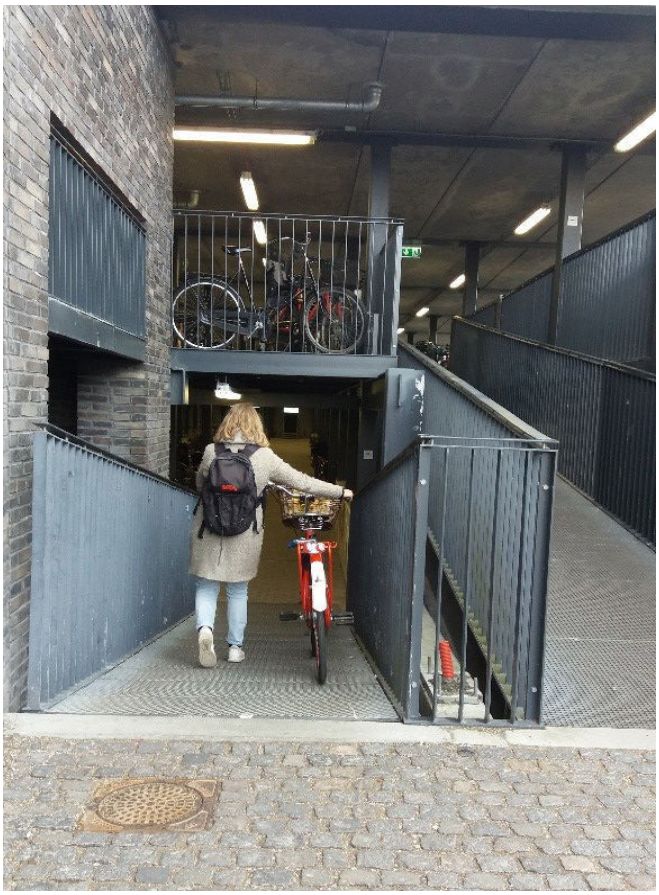
In 2018 funding was approved by the city counsel of Copenhagen to build an automatic underground bicycle parking facility, and Vanløse Station is being discussed as a possible test site[2]. This solution would increase the capacity at the station, but the location of the facility would have to be close to the station to avoid increasing time it takes the commuter to park his or her bicycle. The old landmark at the station entry might serve as a front for the future underground bicycle parking, see picture 7 and 8.

Picture 7: Empty station building and landmark at Vanløse Station

Picture 8: concept drawing of model of automatic underground bicycle parking in Japan

[1] Teknik & Miljøforvaltningen. 2018. "Prioriteringsplan for cykelparkering", Københavns Kommune

[2] Tv2 Lorry. 2018. " Japansk cykelrobot skal løse parkeringskaos", at https://www.tv2lorry.dk/artikel/fuldautomatisk-cykelparkeringsanlaeg-skal-loese-parkeringskaos

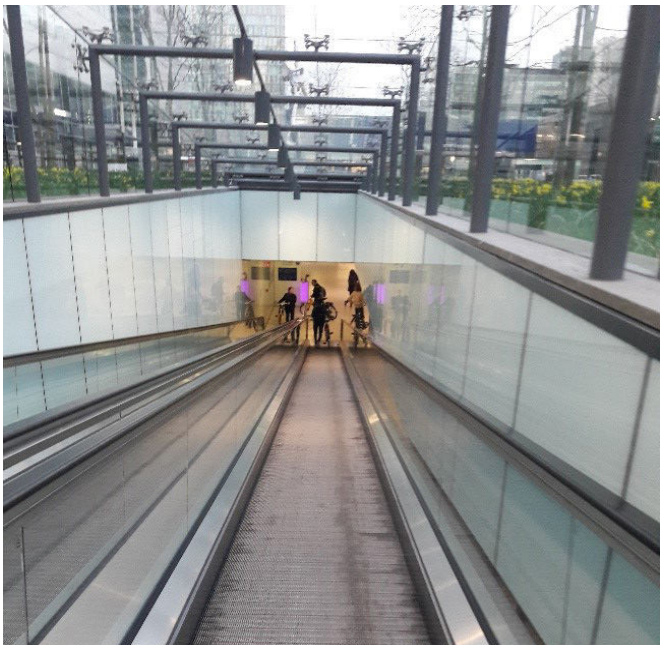


Picture 9: Only entry and exit point at current bicycle facility at Vanløse station

To solve the capacity issues of the future the usage of the current two storage parking facility should be increased. Creating a better connection for bike-train commuters to the platforms from the facility would enhace travel flow and avoid detours from the facility to the platforms, see pictures 9 and 10. Another solution could be to expand the current facility underground and build underground entrance points in direct connection with the bicycle paths, see picture 11 and 12.

Picture 10: Only entry and exit point at current bicycle facility at Vanløse station

Picture 11: Bicycle path in underground parking facility at Utrecht Central.



Picture 12: Underground entry to bicycle parking facility in Amsterdam Zuid.

Potential actors:
DSB Ejendomme (owner of empty landmark), the Municipality of Copenhagen

Potential partnerships: Eco park (automatic underground parking facility contractor)
Potential stakeholders: "Byens Pavillion" (café to be moved) , Indertoften ApS (Owners of undeveloped plot)

5 Tendencies Across Stations

The assessment tool has been used at the selected stations; Ballerup, Flintholm, Hellerup, Herlev, Ishøj, Lyngby, Ryparken, Valby and Vanløse. This has resulted in an identification of potentials for improvements supporting bike-train commuting practices at every station. As figure 3 indicates none of the stations fully meet the requirements for an ideal transit location for bike-train commuters. The stations generally have a potential for improvements, due to the fact that almost all stations have one or more parameters where they perform critically. The following will describe the overall findings of the evaluation of the stations.

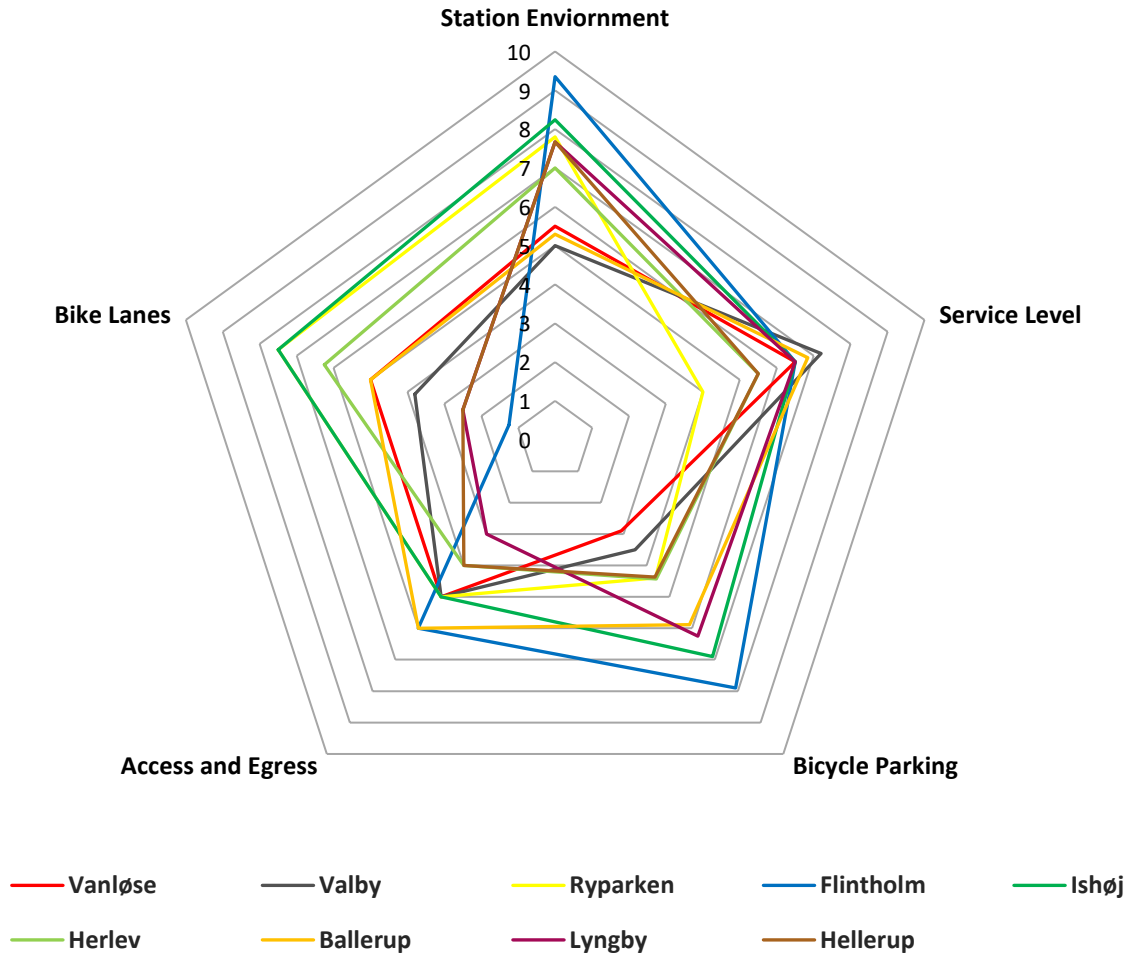


Figure 3 overall station score. Own production

Bicycle Parking – Inadequate and of Poor Quality

Picture 1 bicycle parking at Herlev Station

The bicycle parking at the majority of the stations was of poor quality and in bad condition. Overgrown or broken bicycle racks, abandon bicycles, bad smells and poor lighting are some of the characteristics of the current bicycle facilities at the stations. Even more critical is the absence of different types of bicycle racks. Nowhere was it possible to lock the bicycle to the rack and the only parking area that had designated racks for cargo bikes or other special bikes was Herlev Station. The current state of the bicycle facilities at the station is highly problematic as the bike-train user group own a variety of bicycles. Without the ability to secure the bicycle to the rack the commuting practices of the bike-train user is threaten as they rely on it being there when they return.

Picture 2 interruption of flow at Ishøj Station

Access Routes – Interruption of Flow and Missing Links

Overall, numerous red lights and barriers such as fences, intersections, high curbs and bars across the bicycle path hinders the bicycle flow to the platform and to the parking facility at the stations. There is generally inadequate access to the platform, with narrow stairs and ramps of a low quality. In addition, bicycle routes at several stations do not even meet basic safety requirements such as a separated bike lanes. Even though all stations have less than 500 meters to a bicycle highway, signage to and connectivity with the highway is absent making it difficult and not very intuitive to access the bicycle highway.
These interruptions and missing access points delay the trip to the station and reduces the advantages of combining public transport with the bicycle.

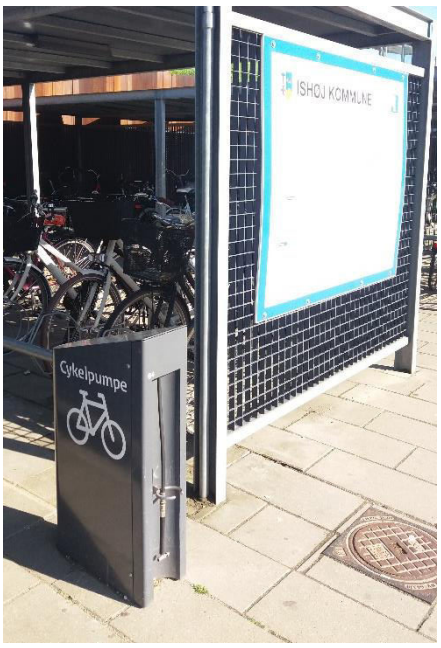
Picture 3 platforms at Ballerup Station

Station Environment – Uninspiring Waiting Time

In general, the stations do not offer more than a minimum level of waiting time value. Every platform and bus stop have covered waiting areas with benches or facades the commuter can lean on. However, no stations offer waiting zones with access to wifi or power outlets. The environment at the platform is in general uninspiring and only serve a functional purpose with no interesting views or aesthetic details. Especially the environment at the platforms seems neglected which is paradoxical as it is here the commuter spend most time while being at the station. Some stations have been upgraded and here only a few details such as an interesting lighting design or greenery have improved the station environment at the station entry. These simple improvements are however both important at the entrance to the station giving a good first impression and at the platform to increase waiting time value.

A Lack of Bicycle Services – Last Mile and Repair Options

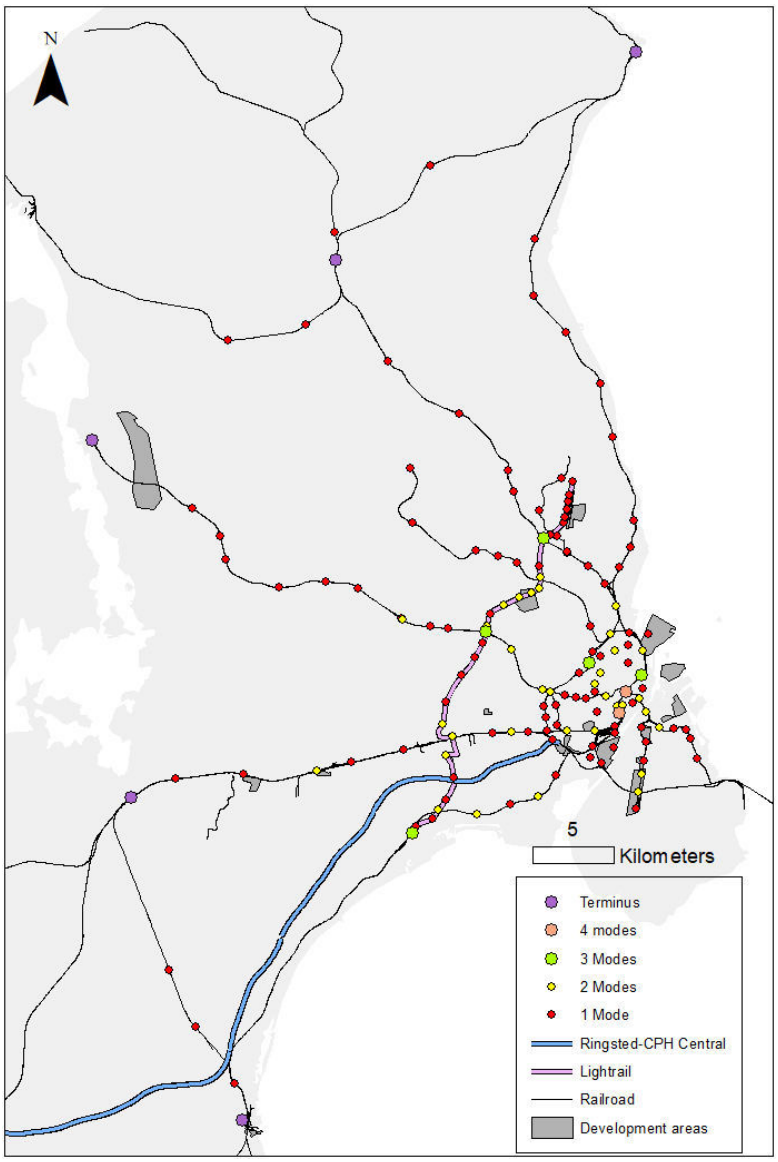
In general, few bicycle services are offered at the stations in terms of repair and maintenance. The majority of the stations offer a bicycle pump but only one station has a bicycle repair shop connected to the station. Having a bicycle repair service in proximity to the station increase the reliability of bike-train commuting and its absence is therefore critical. Furthermore, the stations outside of the city of Copenhagen do not offer a station bike system to cover last mile travel. This is problematic, as the opportunity to travel on with bicycle from a designated station increase the flexibility of the bike-train mode.



Picture 4 bicycle pump at Ishøj Station

6 Future Hubs

Future urban development and transport infrastructure might render other stations than the ones investigated in this visual analysis as potential bike-train hubs. The upcoming light rail running across the suburban area of Copenhagen, the opening of the Metro City Ring, a new metro line from Nordhavn to Sydhavn and a regional express line between Ringsted and Copenhagen central station might create other big transport nodes between 2019-2024. Furthermore, the vision of a fully constructed bicycle highway infrastructure in 2030 might provide more stations with a better bicycle infrastructure in the future.



If we select the future bike-train hubs by employing the vision of the fully developed bicycle high network new stations emerge, see map 5.

Map 5 The map display stations with a proximity of 500 meters to a fully constructed Cycle Superhighway network and how many modes the station will offer in the future. Furthermore, upcoming structures such as the express railroad from Copenhagen Central to Ringsted haven been added along with the light rail along ring. Lastly, urban development areas which will house more than 5.000 people have been added to give a better understanding of future demand in the transport system. Own production.

By adding new infrastructure projects that are financed and being developed until 2024, we find the same bike-train hubs as we have treated in the visual analysis above. However, several new bike-train hubs emerge due to the improved bicycle and public transport infrastructure[1].

2 Modes	3 Modes	4 Modes	Terminus
Amagerbro	Herlev*	Copenhagen Central	Frederikssund
Ballerup*	Ishøj*	Nørreport	Helsingør
Bella Center	Lyngby*		Hillerød
Brøndby Strand	Nørrebro		Køge
Buddinge	Østerport		Roskilde
Christianshavn			
Carlsberg			
Flintholm*			
Forum			
Friheden			
Glostrup			
Hellerup*			
Husum			
Høje Taastrup			
Ishøj*			
Kongens Nytorv			
Nordhavn			
Nuuks Plads			
Nørrebros Runddel			
Ryparken			
Rødovre			
Rådhuspladsen			
v/ Buddingecenteret			
v/ Dynamovej			
v/ Gladsaxevej			
v/ Gladsaxe trafikplads			
v/ Glostrup Hospital			
v/ Herlev Hospital			
v/ Herlev Hovedgade			
v/ Vallensbækvej			
Valby*			
Vallensbæk			
Vanløse*			
Vesterport			
Vibenshus Runddel			
Ørestad			

*Tabel 1 potential future hubs. Stations marked with * are the already selected hubs which have been analyzed in the previous segment.*

The new potential bike-train hubs are mainly stations, which connects the new light rail going across in the outer suburbs of Copenhagen with either S-train or E or S busses. The new stations

[1] This selection of potential future bike-train hubs is solely based on amount of available modes with no examination of the stations passenger counts and frequency, as done in the previous selection. Furthermore, we decided that only E, R and S busses represent the bus, and they are only viable to count as a mode if their stop is located within 150 meters of the train station.

emerging in the next 10-15 years emphasize how fast the transport system is growing and pinpoint that numerous locations might be valuable sites for bike-train hubs. In our analysis the focus has mainly been on 1) suburban stations like Herlev, Ishøj, Lyngby and Ballerup, which are connected to the local area with an extensive bus service, 2) stations with a high connectivity and distribution value in the public transport network such as Valby, Hellerup, 3) stations like Flintholm, Vanløse, and Ryparken which are stations in the outer boroughs of Copenhagen connecting different S-train lines or metro lines running across the city.

However, a more strategic approach might be applied when choosing sites to promote bike-train travels. Our selection method does not evaluate the importance of population density in the stations catchment area nor the amount of services and functions. Stations like Hillerød, Frederiksund and Helsingør, which are provincial towns, does have a high population density within their catchment area and important functions in close proximity. Nevertheless, these stations still have value as important public transport nodes in the Fingerplan[2] and might be added to the list of future bike-train hubs. Additional stations outside of the region such as Roskilde and Køge, which have not been in the scope of our visual analysis, is pinpointed as important transport nodes in the development of the capital region. These stations have been added to the list of future potential hubs as well, see table 1 above.

[2] Erhvervsstyrelsen. 2017. "Fingerplan 2017 - Landsplandirektiv for hovedstadsområdets planlægning". Erhvervsstyrelsen, København.

PART III - Essay

1 Introduction

We will now discuss how bike-train commuting can become a sustainable alternative to the established transport system, in a current socio-technical system where the institutions are reluctant to support the mode.

The first part of our essay will discuss specific structures of the current bike-train system that are undesirable in an environmentally sustainable perspective and under which conditions the bike-train mode might be able to compete with the automobile. The perspectives presented are based on PART I of the thesis investigating bike-train user practices. The second part will discuss under which terms the bike-train mode can be upscaled and how the issues derived from the capacity problems in the trains needs to be taken into account if the bike-train can grow and become a desirable mode of the future. The third part will discuss where the responsibility of supporting the bike-train mode now and in the future, might lie. The focus will be on whether the traditional transport institutions can promote the bike-train mode or if a paradigm shift is required. Finally, the fourth part will address the car logic, which encloses much of the current transport policy, and propose an alternative practice-based planning approach.

Throughout the essay, there will be drawn parallels to experiences from the Netherlands, where bike-train transport is the only growing mode (Kager et al. 2016) and is prioritized by the institutions within their transport system. This discussion will employ statements from conducted expert interviews with researchers studying the bike-train mode and bicycle highways from the Netherlands, and the director of the development of bicycle highways in Gelderland, a region in the Netherlands. In addition, the discussion will make use of statements from a representative of the Cycle Superhighway Secretariat (CSS) in the Capital Region of Denmark and the Chief of Planning in the Danish Train Operation Company (DBS) who have been engaged in supporting the bike-train mode since the late 80's. The two institutions are represented in the discussion to debate their position in the current socio-technical system in regard to developing the mode of bike-train commuting.

2 Unsustainable Structures of the Current Bike-train System

Until this moment, we have assumed that the bike-train mode is a desirable mode in terms of moving towards an environmental sustainable transition of the transport system. This makes sense, as cycling seen in insolation is the most sustainable mode of transport besides walking (Pucher & Buehler 2017). In addition, public transport is often considered a more environmental friendly alternative to the car (Kenworthy & Newman 2015). However, it is not as simple as that. The key to this question is; what would be the alternative to taking a bike-train trip?

2.1 The Effect of the Ticket Structure on Bike-train Practices

Our empirical data imply that the bike-train mode both encompasses positive and negative aspects, and whether or not the bike-train mode it is a transitional pathway to a sustainable transport system is closely related to which trips the mode replaces.

When looking isolated at which trips the bike-train mode replace on the interviewees commute, it is found that a majority would never bike the whole commute as the distance is too far. The bike-train mode enables them to cycle a part of their commute and often replace the car or other public transport. In this regard, the potential of the bike-train mode as being a sustainable alternative is confirmed. However, our interviews revealed that the current ticket structure of the *Pendlerkort*, a monthly paid commuter pass, has a significant effect on the attitude towards using the bicycle in their leisure time.

> *"[...]It's also because I have my commuter pass (Pendlerkort), so it's actually become more likely that I take the bus if it rains because now I've paid for it." (Bike-train commuter)*

Another bike-train commuter who used to bike everywhere goes even further and explains how the monthly paid commuter pass has affected his choice of transport:

> *"Beforehand I would never use public transportation, but back then I did not have a monthly commuter pass. So, there was an economic barrier every time I chose to use the bus for instance. Now when I have paid for the "party", I might just as well enjoy it. Now I don't have to worry about money, so I can just ride around without thinking about paying x-amount of money on my travel card [Rejsekort ed.]" (Bike-train commuter)*

The existing ticket structure seems to affect bike-train commuters cycling patterns decreasing the kilometers they bike in their leisure time and on their commute. Some of the users reduce the distance traveled on bicycle for comfort reasons and because they feel that they have to make the most of the expensive pass. There is no deduction in price if you desire to bike the whole trip some

days during the week; *"I have a commuter pass. So, I can bike so much, but I do not save a penny, I have no financial gain from it". (Bike-train commuter)*

In order for the bike-train mode to pose a serious sustainable alternative of transport, the ticket structure needs to be adjusted. Taking the train or the bus is on paper environmentally more desirable than taking the car. However, if the public transport mode "steals" former cyclist or bike trips, it can be discussed whether bike-train commute is a desirable future situation both environmentally and health-related. Though one might argue, that it is not the bike-train mode in itself that affects the fact that some seem to bike less, it is the system of which the bike-train mode is a part.
In order to promote the bike-train mode as a sustainable trajectory, the reform of the ticket structure holds a significant potential. A future system should ensure incentives for the users who wants to cycle further on their bike-train commute but also prevent users who normally would have taken the bike to take public transport instead. In a practice perspective, economic incentives to help promote sustainable choices can be questioned as behavior is determined by elements of practice and not a result of rational choices. However, Watson (2012) argue changes in the price structure can show to be effective if they initiate changes in the practice. When we suggest a change in the ticket structure, it is not based on rational behavior, but on the knowledge of the former practices of the bike-train commuters before they acquired a monthly commuter pass. Bike-train commuting is a dynamic practice as the commuters do different things during the week, and during the day, therefore it is necessary with a flexible ticket structure that can cope with this in a way that support sustainable choices.

2.2 The Effect of Bicycle Infrastructure on Bike-train Practices

We have used the Cycle Superhighways in the Capital Region of Denmark and the vision behind them as a benchmark in our selection analysis of potential bike-train transit stations in *PART II Future bike-train hubs* in our thesis. However, our analysis of the station areas showed that the connection between the station and the Cycle Superhighways in almost every case were missing. In addition, the Cycle Superhighways we examined did not meet the general guidelines of bicycle highways in term of route quality and creating access routes between station and the bicycle highway (Transportministeriet 2016). It raises the question of whether the infrastructure of the Cycle Superhighways is fitted to support the bike-train system contributing to a sustainable transition.

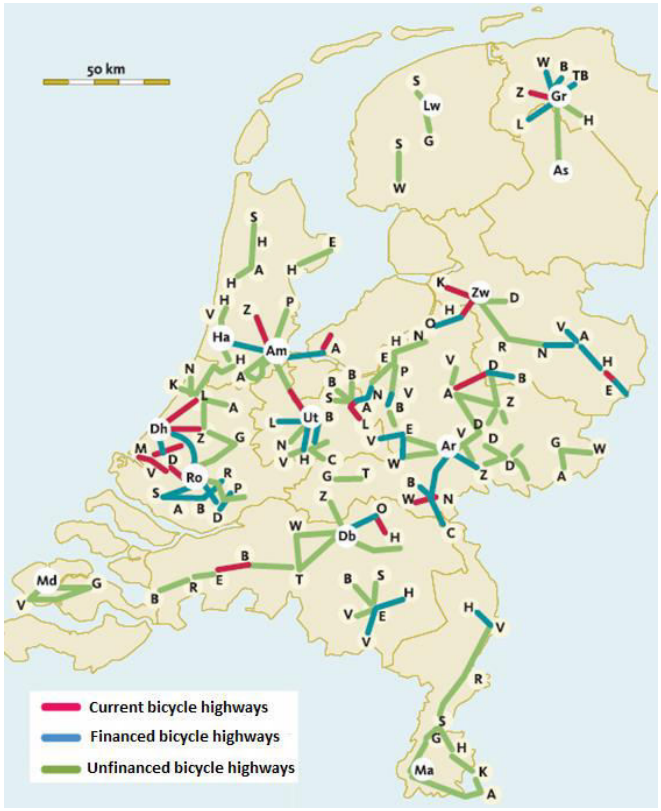
The purpose of the Cycle Superhighways is *"to create a competitive transport option to the private car and public transport, thus increasing the number of bicycle commuters in the region"* and at the same time *"[…] a Cycle Superhighway should make it easy to combine a bike commute with public transport"* (Supercykelstier 2018). These different statements can seem as a contradiction as the

Secretariat for Cycle Superhighways both wishes to compete with public transportation and to promote better opportunities to combine bike and train. The Cycle Superhighways in the Capital Region of Denmark is mainly constructed along railroads, going to and from Copenhagen, see map 2, and their main target group is long distance bicyclist commuters (5-20 km one way) in the capital region (Supercykelstier 2018). However, as we have shown in *PART I Mobility practices of bike-train commuters*, our study indicates that the majority of bike-train commuters cycle less than 5 km on an average day while a minority cycle long-distances. The routes running beside the train tracks seem mainly to support the minority of bike-train commuters cycling long distances in one-direction on their commute. This fact makes it worth considering whether the Cycle Superhighways are what should be invested in to support bike-train travel in the future. The Cycle Superhighways in the Capital Region of Denmark might only be competing with public transportation and not the car, as long as they run along the rail corridors towards Copenhagen, see figure 2. The vision of providing an alternative to public transportation is in theory a sound idea, following the argument that it is more sustainable. However, the vision of providing an alternative to public transport is not what the real issue is; the bigger goal must be to create a system able to compete with the car (Kenworthy & Newman 2015).

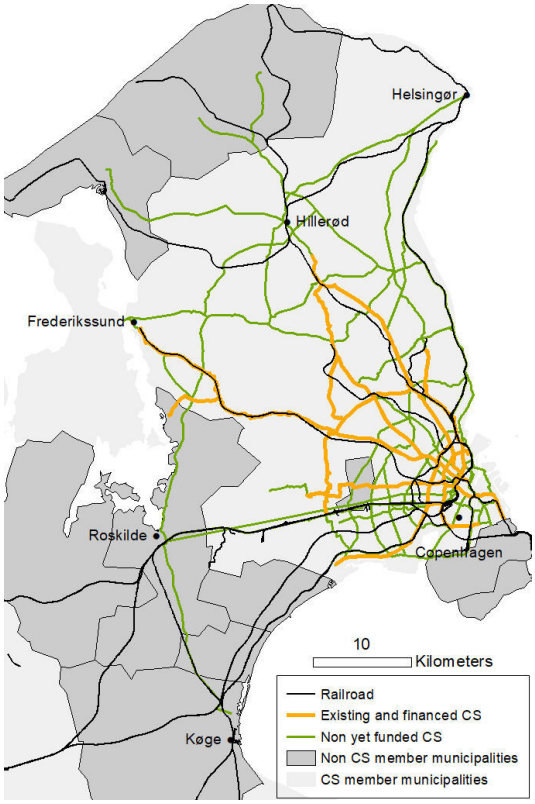
According to Researcher in the project *Smart Cycling Futures* from the Technical University of Eindhoven, George Y. Liu it is important to raise the quality of the bicycle infrastructure in proximity to a station. In order to compete with the car increasing the local catchment area of the stations is necessary. He argues that the construction of bicycle highways running side by side with the rail is a solution without much effect;

> *"If the distance is too long and the train offer a faster alternative, is it even reasonable that you can steal people from the train? - the answer to this question is, that if there is 30 km from origin to destination no one is going to pick the bicycle over the train" (Liu 2018).*

This quote raises the question if the structure of the Cycle Superhighways in the Capital Region is the most adequate to promote the potential of the bike-train mode. As the structure is now, the Cycle Superhighways does not connect the station with the potential catchment area. This current system only considers the needs of bike-train commuters cycling the long-distances that Liu deem impossible; commuters who bike the entire distance in one direction and bring their bike on the train in the other direction.



Map 1 showing the network of regional bicycle highway "snelfietsroutes" in the Netherlands (Fiets Filevrij 2015).



Map 2 showing the future Cycle Superhighways (CS) network. (Own production)

When looking at the differences in bicycle highway infrastructure in the Netherlands and the Capital Region of Denmark it can be observed that the Dutch model to a much larger degree connect with the public transportation network. The routes are rarely more than 15 kilometers and they join central stations in the larger cities with the surrounding towns, see map 1. The ability to compete with the car in regard to transport time is significantly increased with a combination of bike and train (Region Hovedstaden 2018). Creating better flow and increasing speed for cyclists in the catchment area of a station could improve the potential of the mode and enhance the mode's ability to compete with the car. The Dutch bicycle highway model, recognizing the synergy effect between bicycle and train and the value it has in competing with the car driving practice. According to Wietse Bruggink, regional planer of bicycle highways in Gelderland;

> *"Most of the bicycle highways that goes towards bigger towns or cities are going towards the central station. To us, the intermodal part is very important […] the link to the station is of great importance, and it is something that we take into account when we plan bicycle infrastructure."* he further explains that in some cases *"the bicycle superhighway actually ends at a ramp to the bicycle parking at stations (Bruggink 2018).*

In order to fulfill the full potential of the bike-train mode and contribute to a sustainable transition in the Capital Region of Denmark, we might need an addition to the concepts of the Cycle Superhighways. Our results indicate that there are different bike-train commuters with different practices. We know that some desire to bike long distances and others shorter distances. Therefore, it might be necessary to support both the bike-train commuters cycling long distances already targeted by the Cycle Superhighways, but also to improve the overall standard of bicycle routes in the catchment area of a station, which will target bike-train commuters riding shorter distances. With that said, it is important not to neglect or forget the current infrastructure objective of the CSS.

> *"Making bicycle highways is improving the entire network. We see that e-bikes and speed pedelecs are on the rise in the Netherlands, and the normal bicycle infrastructure network are not always suitable for these modes, but cycle highways are. With these two modes there are a bigger chance to get people out of the cars and unto the bicycles due to their speed, so I think the bicycle highways are important in this phase as they will be vital elements in supporting this type of commute in the future." (Bruggink 2018)*

The sale of e-bikes is also increasing in Denmark (Partnertekst 2017) and the road traffic authority have just initiated a pilot project with speed pedelecs (Færdselsstyrelsen 2018). The bicycle infrastructure that the CSS are currently facilitating will increase the speed and potential of these types of bicycles.

2.3 Final Remarks on the Sustainability of the Bike-train Mode

Based on the insights in the practices of current bike-train commuters we argue that the bike-train mode holds the potential of being a sustainable and competitive alternative to the car if investments and reconfiguration in infrastructure and ticket structure are made. However, our user analysis also shows that bike-train commuters who used to be car drivers substituted their commuting by car when they were met with congestion or increased parking fees and "forced" to do something else. Restriction of the automobile might therefore be just as important parameters in a sustainable transition as bicycle infrastructure or reform of the ticket structure. The sustainable potential of the bike-train mode seems dependent on a weakening of the dominant socio-technical transport system where the car reign supreme, Bruggink explains:

> *"I always say, if one person is getting out of the car there will be another one taking his place, so bicycle highways won't help to diminish the congestion. But, it helps to make the city more assessable, because you can always go there by bike even when there is congestion."*

Pedersen and Jørgensen (2001) further back up this statement:

> *"In itself the support for bicycling from the political system is not a significant signal for a change in the transport regime. An integrated transport policy creating a segmented transport system giving priority to bicycling and public transportation in certain areas and for certain types of transportation is needed to reach the point where a regime shift from the car based regime, to a regime based on inter-modal systems is on the agenda" (Pedersen & Jørgensen 2001: 27).*

3 Capacity Issues - An Obstacle for Upscaling?

In a transition perspective, the upscaling of bike-train practices will have numerous implications to the current public transport system. Already capacity issues stand in the way of a future expansion of the mode. Since 2011, when DSB made it free of charge to bring bicycles on the S-train, the number of trips have increased significantly. According to DSB's yearly report of 2016 the bicycle is a part of more than 10 million trips annually on the S-train lines, a number that has increased by 1.4 million trips between 2014-2016 (Sandholm 2017; DSB 2016b). To put this into perspective, the S-train had 116 million trips in 2016, which means that the bike-train mode account for 8.6 % of the total passenger count (Transport- Bygnings og Boligministeriet 2016). The rapid growth is causing capacity problems, and that is even though DSB have tried to combat this by adding a train compartment for bicycles in most train sets (Sandholm 2017). This development affects the discussion of the potential to upscale the bike-train mode in a sustainable transition. The current situation causes frustrations among the bike-train commuters that choose to bring their bike with them on the train.

> *"[…] if I just could be able to place the bike, and still stand up, it would be alright. But, with the bike on the train you always have to move around, because people are entering and leaving the train. It won't be a relaxed journey. […] There is also that annoyance that people go in and out of the same place as me. I always try to hit their legs with my wheels, just like "to teach them a lesson" like a revenge, or I'll place my bike across the compartment so they cannot go out with me and have to wait." (Bike-train commuter)*

The current capacity issues in the train causes tension in the bike-train practice as the trip is perceived as more stressful and conflicts with other passengers can emerge due to the tight space in the train compartments. A "them and us" feeling emerges between the bike-train commuters and other passengers, and the positive meaning of relaxation the bike-train commuters attribute to the practice disappears during peak hours. The fact that the bike-train commuter has to fight for the

space with other passengers imply that the bicycle is entering another socio-technical system were passengers only using public transport is given more priority. To maintain the current practice of bike-train commuters and to upscale the number of bike-train trips the capacity issues give rise to a discussion of whether we should reconsider the concept of bringing the bicycle on the train or to completely rethink the bike-train relation.

In the Netherlands, it is only possible to bring the bike on the train outside of rush hour and there is a 6.20-euro fee irrespective of the number of kilometers travelled by train with a bicycle (Nederlandse Spoorwegen 2018a). This decision was made as the railway company anticipated too many customers would bring their bike on the train, Marco Te Brömmelstroet explains:

> *"Bicycles on trains are just unscalable. One person with a bike take up the space of five without a bike. In the Netherlands 600.000 of the 1.2 million train trips every day start or end with a bike. It would be impossible to bring just a fraction of those bikes on the train on a daily basis. The ticket scheme does not support bringing the bike on the train, since the bike share system is cheaper than tickets for bike/train" (Te Brömmelstroet 2018).*

In Denmark, however, the railway company, DSB, is glad that they can provide this service to their customers, but they do not plan to expand the capacity further, they would rather use the already existing capacity more effectively:

> *"We would like to take advantage of the already existing capacity [of bike spaces on the s-train], but we do not wish to expand the concept further. If we introduce more bicycle on the S-trains than we already have, it will begin to cause delays, so it is a delicate balance. We are however very glad that we can provide this service for our customers, even to those who only bring the bike on the train occasionally. We believe providing the opportunity makes it more desirable to take the train, and I think the service have come to stay" (Pilegaard 2018).*

This stance might stem from the immense success and number of new customers DSB have gotten since they introduced the initiative back in 2011. This is further underlined in DSBs procurement requirement of new train sets, which states that the new train should have 5-20% space allocated for space that supports bikes (DSB 2017). However, bringing the bicycle on the train have a limit as the rail system in and around Copenhagen is currently working under full capacity (Trafikstyrelsen n.d.). What this means, is that it is not possible to add more trains during rush hour, and that the system is vulnerable to unforeseen delays. This is alarming for the bike-train mode as the experience in public transport must be on par with the flexibility and freedom they have on the bicycle lane for the mode to be sustained or to grow in the future. On one hand, the possibility of bringing the bike on the S-train causes many frustrations among the bike-train commuters, but on the other hand, our study also shows that for some, this opportunity enables a practice that previously would have

been impossible. Many of the commuters experienced the distance to their workplace as a barrier for them to go by bicycle *all* the way. So, bringing the bicycle on the train in one direction has enabled them to go by bicycle the entire distance the other way. This results in a trip on bicycle, which would not otherwise have been taken.

In theory, a national network of stations bikes could replace many of the bike-train trip constellations where people bring their bike on the train, since there is no real need for the bike *on* the train. However, having their bike with them all the way provides the bike-train commuters with a flexibility that is hard to ensure in the same way without a national station bike rental scheme. The current available rental scheme of the capital region is called *CityBike* (Bycyklen). It was incepted in 2014 and is limited to operate only within the city border of Copenhagen (Bycyklen 2018). This makes the scheme obsolete for many users as it does not cover urban areas outside of the city where they might commute to and from. The system would have a bigger impact if the operational area covered the whole region as more users would be able to rely on it in their daily commuting practice.

In the Netherlands a station bike scheme called the OV-fiets was instigated in 2002 by a start-up company and later adopted by the Dutch National Train Company (NS) (Te Brömmelstroet 2018). The scheme provides bicycles at over 300 NS stations all over the country. The users are able to rent a bike for 24 hours for 3.85 € and lock it anywhere they want, they do however have to return it to the same station (Nederlandse Spoorwegen 2018b).

In comparison the Danish CityBike offer a subscription which cost 9,5 € a month with a minute rate of 5 € cents. The scheme is not meant for long term rental as the user can return the bike to any designated CityBike station placed all over the city (Nederlandse Spoorwegen 2018b).

The OV-fiets is expected to have 3 million rides in 2018, a number that is predicted to grow to 4 million in 2020. The system consists of 10.000 bikes and NS sees it as an immense success (Miedema 2017).

In comparison the Danish CityBikes had a little more than 900.000 rides in 2016 and the system consist of 1860 bikes (Hjorth 2017). Despite the high number of rides compared to number of bikes, the CityBike is often the subject of criticism. The main criticisms are often based around; the high purchase price of each bicycle as the system is constituted of e-bikes (3355 €) (Bycyklen 2018), and the difficulty in maintaining the bicycles which result in only ¾ being available for use (Bencke 2018).

From a bike-train commuting perspective however, it is the fact that the Dutch OV-fiet is more widespread that makes this system superior to the Danish CityBike. Anne Pilegaard, Head of the planning department in DSB, express that she thinks it is a shame the the CityBike is not more widespread in the capital region:

> *"It was the thought that the CityBikes operational area should be widened. However, I don't know if that will happen. It might be too difficult and expensive which is a shame. [The operational area] has to be widened for the system to work as its intended purpose; a reliant commuter bike" (Pilegaard 2018).*

Even though a national station bike scheme might offer first and last mile solutions and reduce the capacity issues with bicycles on the train, the problem might just be moved. In the Netherlands new issues have arisen in the wake of the success of the station bikes:

"In the morning (8.30) the OV-fiets are all used and out driving while the bicycle parking for regular bikes are filled up at the station. It could be good with a P2P bike sharing system to increase the use of the parked bikes at the stations, 20 mio bikes in the whole of the Netherlands - we should share them with each other" (Te Brömmestroet 2018).

Marco Te Brömmelstroet argues that there should be a focus on better utilizing the privately-owned bikes that are already at the station through peer-to-peer bike sharing services. This could prove an effective solution if implemented right, as the service would prescribe a large degree of flexibility and a wide variety of bicycles available. As the mobility practice of bike-train commuters depend on a variety of different bicycles such as a cargo bike or a racing bike a P2P service might help support and upscale bike-train commuting. Furthermore, as Te Brömmelstroet argues, there would already be plenty of bicycles available to support such a system, on average every Dutchman owns 1.3 bicycles while every Dane own 0.8 bicycle (Bicycle Dutch 2018).

Overall, to deal with the current capacity issues in the train and support a sustainable transition several initiatives needs to be developed further. From a practice perspective the possibility of bringing the bicycle on the train should also be possible in an upscaling of the bike-train system as it enables commuters to bike longer distances. A regional or national station bike solution might help remove some of the pressure in the bicycle compartments. That being said, it may be necessary to rethink the station bicycle rental scheme, as we discovered that different materials enable different kinds of bike-train commuters to have different commuting patterns. Therefore, a future station bicycle scheme must be comprised of more than the schemes we know today. It should consist of a variety of different types of bikes, cargo-bikes, electric cargo bikes, city bikes, racing bikes, electric bikes and so on to support and enable different kinds of bike-train commuting practices. Such a scheme could have a peer-to-peer bicycle sharing element to it, to better provide the commuters with a wide variety of bikes and to take advantage of the already existing resources which is privately owned bicycles.

4 Established Institutions and the Bike-train Mode

The bike-train mode is "a bottom up emerging system" not planned for by the traditional public transport institutions (Pedersen & Jørgensen 2001; Te Brömmelstroet 2018). To support the bike-train mode toward a sustainable transition therefore prescribe cooperation between the institutions within the transport system. The mode forces public transport institutions, local planning agencies and bicycle organizations to collaborate in new ways (Pedersen & Jørgensen 2001). However, despite of the increased attention the mode has received in recent decades by transport institutions such as DSB and CSS the mode only represents a small share of the trips made in the capital region (Region Hovedstaden 2016). This raises the question if current transport institutions and organizations targeting separate transport modes are capable of supporting bike-train trips and enabling a sustainable transition.

4.1 A Fragmented System – the Need of a System Approach

Our findings from *PART II Future Bike-train Hubs* suggest that areas of transit still are lacking basis infrastructure to support bike-train commute. Materials such as secure bicycle racks or safe and continuous access routes are still an issue after 40 years of attention on bike-train combination in the capital region. To identify why this is the case we look to the Netherlands where the bike-train mode is the only mode significantly increasing in number of trips per person (Kager et al. 2016). The policy in the country have developed from a reactive policy approach to the emergent of bike-train trips to a proactive support of the mode;

> *"In the Netherlands the authorities have had a reactive policy approach to bike-train trips. The railway organizations have however finally realized that they have to invest in bicycle infrastructure as the bicycle is a feeder mode that can optimize timetables and save time on departures" (Te Brömmelstroet 2018).*

However, places of transit are not the only infrastructure being accommodated to the bike-train mode. The planning approach to bike-train trips have in recent years co-evolved with the planning of bicycle highways in the Netherlands. One of the key elements in creating bicycle highways is to ensure good accessibility to the station from the surrounding catchments area.

> *"Good parking conditions at the station have been established ahead of the bicycle highway, that is the case most of the times. We therefore provide a good accessibility to the station with the bicycle highway [...] The link to the station is very important, and it is something that we take into account. I have a colleague who work together with the national government and the rail infrastructure company. They take care of parking and accessibility when making a new station or a new bicycle highway to the station" (Bruggink 2018).*

When comparing the Dutch approach to the bike-train mode to the Danish planning initiatives, evident differences emerge. Returning to the Capital Region of Denmark the purpose of the Cycle Superhighway seems to be essentially different. Jakob Villien employed in the Cycle Superhighway Secretariat explains:

> *"It could be a future assignment for the Cycle Superhighway Secretariat to connect the bicycle highways with the stations. However, our organization is not founded to fulfill that responsibility we primarily focus on long distance bicycle commute. It is the municipalities job to upgrade the access routes to the station, all we can do is recommend it" (Villien 2018).*

In the Netherlands the mode seems to be prioritized across different planning agencies and transport institutions. According to Bruggink (2018) the railway company in the Netherlands have responsibility not only to build bicycle parking on their stations but to ensure that the stations are connected to the local bicycle infrastructure.

When asked if the train operating company in Denmark construct access routes to their bicycle parking facilities Anne Pilegaard explain;

> *"No, but we are in contact with many municipalities to ensure good access routes for bicyclists. [...]We make them aware of the problem, if there haven't been thought of ensuring access routes."* The cooperation with the municipality does however not always run smoothly. *"When we need to solve complicated bicycle parking issues, such as the situation at the central station of Copenhagen, it becomes very expensive. It is too expensive for us (DSB) and for the municipality, and who is it then that should solve the problem? Then nobody takes responsibility because it becomes too expensive and that's a shame. The issue falls between two stools" (Pilegaard 2018).*

In the Capital Region of Denmark 29 municipalities are responsible for constructing bicycle infrastructure inside their own borders. The ambitions are evidently different from the six municipalities not even participating in the regional Cycle Superhighway cooperation to others like the Municipality of Furesø who construct high quality bicycle parking at stations connected with the established Cycle Superhighway crossing their municipality (Supercykelstier n.d.; Furesø Kommune n.d.). This political difference makes it difficult to raise the overall standard of the regional bicycle highway system as the municipalities have different ambitions (Villien 2018). Even through the structure of the political system is similar in the Netherlands, the political conditions for promoting the bike-train mode seem fundamentally different;

> *"As a province we don't build the bicycle highways ourselves, we help municipalities to build them, so if there is more than one municipality they will have to agree that they want a bicycle highway. So, there is always a political*

> *factor and there is always a financial factor. However, I don't think there is a real lack of money and there is a willingness to invest in the bicycle highway projects" (Bruggink 2018).*

In the Capital Region of Denmark different transport institutions, organization, and local planning authorities try to influence and affect the bike-train mode. Even though the bicycle is considered a core element in a future sustainable transport system, no radical change seems to be achieved as long as isolated policies try to promote bike-train trips (Olafson et al. 2016; Pedersen & Jørgensen 2001). When conditions for bike-train commuting is improved it is often by upgrading local bicycle routes, building bicycle parking at the station or allowing bicycles on trains (Pedersen & Jørgensen 2001). Our analysis in *PART II* of the thesis of nine station areas in different parts of the region suggest that these initiatives become "islands" of improved infrastructure. The fragmentation in planning authority is evident in the missing synergies between bicycle highways, access routes, and station areas.

In the Netherlands the integration of the bike-train initiatives appears to run more smoothly with a clear distribution of responsibility across various agencies. Supporting the bike-train mode seem embedded in the policy of train operators, as well as regional and municipal authorities planning the bicycle infrastructure.

The railway institutions are beginning to support bike-train travel by changing departure times, cooperating with bicycle highway authorities and constructing bicycle parking facilities of high quality at major stations (Bruggink 2018; Te Brömmelstroet 2018). In comparison, brand new parking facilities at Lyngby and Vanløse station in the capital region are decoupled from the bicycle path and only offer standardized parking racks. When asked about the notion to offer a higher level of bicycle services at some transit nodes Pilegaard argues: *"For us (DSB) it is still a new thing, for many years we have been focusing on offering a standardized service level at every station, so people can know what to expect when they arrive at a station"* (Pilegaard 2018). The notion of not deviating from the "normal" and the "standardized" in regard to bike-train trips that Pilegaard talks about, pose an obstacle to enhance the experience and connectivity on stations for the bike-train commuters. Overall, the main issue in the Capital Region of Denmark seems to be the absence of an institution in the current transport system that can take lead in supporting bike-train trips and ensure a connection between the bicycle and train system.

> *"I think all actors; the municipalities, transport companies both public and bike, needs to have a good cooperation across institutions to promote bike-train trips. But it is important that somebody take the lead, so something actually is done" (Pilegaard 2018).*

Despite an interest in bike-train trips, the statement above from Pilegaard suggest a reluctance in DSB to be instigators of a transition establishing the mode as a sustainable alternative to the car.

4.2 Stages of the Transition

The difference between the Danish and Dutch transport institutions in the willingness to support bike-train trips might be attributed to different stages of transition. By comparing stages of transition of the bike-train mode in the two countries we discuss what institutional conditions might contribute to a sustainable transition in the Capital Region of Denmark.

Currently the CSS are trying to instigate pilot projects beneficial for the development of the bike-train mode by gathering public transport providers such as DSB and bicycle organizations such as CityBikes. Pilot projects that can serve as incubators resulting in a more widespread support of the bike-train mode. To be the organization to push the development of bike-train commute forward is however difficult. The CSS is a result of regional cooperation, as different municipalities opted for working together more closely than previously, to improve the bicycle infrastructure in Greater Copenhagen, to combat growing congestion problems. The CSS currently consist of five full time employees (Villien 2018).

> *"People think is it strange when we talk about bike-train trips. People are like "that is not your job to fix" but nobody else is taking it upon themselves to promote it" (Villien 2018).*

The secretariat has no funds of their own to post into creating new bicycle highways and rely on the individual municipalities will to upgrade suggested routes to bicycle highways. At the same time, the future of the CSS is uncertain, as their continued existence depends on willingness of the region and municipalities to finance them for another year. According to Villien (2018) the organization is *"making the best of a bad situation"*. Without an actual regional or national bicycle institution providing bike-train infrastructure on a competitive level with the current public transport and automobile institutions a transition towards a sustainable transport system, seem unreachable.

While the CSS fight to finance and upgrade certain regional routes of bicycle infrastructure, the planners in the Netherlands does not have to worry about the willingness to invest. Instead of upgrading current routes the Region of Gelderland often, construct new and more direct bicycle paths.

> *"The biggest challenge in planning for the bicycle highway is the, not in my backyard issues (NIMBY) the missing links are important for us to deal with and sometimes it is hard to buy land because people are afraid that, a bicycle highway will mean speedy bikes and it will be unsafe for their children, when they are playing or learning to cycle in the streets" (Bruggink 2018).*

It is clear when comparing the investments in bike-train infrastructure made in The Capital Region of Denmark and the Dutch Region of Gelderland, that the two regions find themselves on different stages of a transition, see table 1. The share of the funds spent on bicycle infrastructure is closer to

the infrastructure investments in the other transport systems in the Region of Gelderland than in the Region of Copenhagen, see table 1.

	Bicycle highway budget (17-19 km bicycle route)	**Investments in bike-train** (national funds)	**Investments in public transport**	**Investments in automobile infrastructure**
Capital Region of Denmark	**8 million euro** (*Vor Frue-Køge Nord* route)	**13 million euro in 2018** Funding bicycle routes	**900 million euro** *Light rail (Suburbs)* **2,840 billion euro** *Metro Cityring* (new line Copenhagen)	**83 million EUR** (*Nordhavntunnel* Copenhagen) **3,640 billion EUR** (*Østlig ringvej* Copenhagen-proposal)
Region of Gelderland	**17 million euro** (*RijnWaalpad* route)	**50 million EUR per year till 2022** Funding bicycle parking and bicycle highways	**24, 2 million euro** New railroad terminal **53,5 million euro** Upgrade of the regional rail	**180 million EUR** Connection of A12/A15 freeway

Table 1 (Bredsdorff 2018, Bruggink 2018, Rådgivende ingeniører n.d.; Østergaard 2016; Rambøll & Strategiske analyser 2012; Social Demokratiet 2017; Nijboer 2016; MIRT 2016; OV Magazine 2015)

To understand difference between the two countries the transition trajectory of the bicycle highway infrastructure can be compared to the development of the road system the last century. Currently the Danish CSS is facilitating an upgrade of the current bicycle infrastructure, while the planning agencies in the Netherlands is building new and faster bicycle highways. Here dealing with expropriation and citizens complains is the main challenge, just as modern-day expansion of the motorway for cars (Bruggink 2018; Jørgensen 2001). Following the industrialization and the normalization of the car the Danish road network has been upgraded continuously between 1930's to the 1960's by municipalities and counties in Denmark. Following this transition from cobblestone streets to multilane roads construction of the motorway network began in the 60's and are still being developed till this day. In 1963, the construction of the motorway network became the responsibility of the state and the Danish Road Institution (Vejdirektoratet) has since been a powerful institution in the transport system creating a continuous national network for cars (Jørgensen 2001). Following the trajectory of the road network, similar stages can be identified in the establishment of the bike-train system. Compared to the development in the Netherlands the bicycle highway network in the Capital Region of Denmark might be in an early phase of the transition of the bike-train system fighting to upgrade and create continuous cycle network across municipal borders, see figure 1.

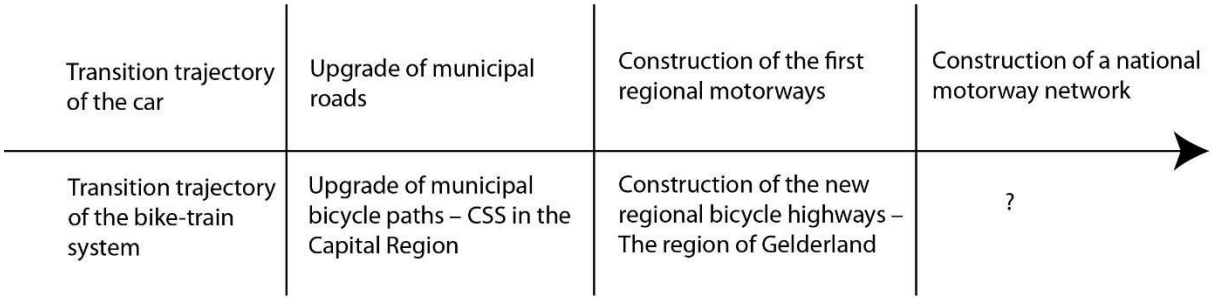


Figure 1 comparison of bicycle highways and Danish road transition trajectories

If the bicycle highway network is to follow a similar transition trajectory as the Danish roads, the next step in the transition is the establishment of a national institution. Just as the Danish Road Directory a national bicycle institution could be responsible for the planning and construction of the elements in the bicycle system including bike-train improvements. The current development suggests that none of the established institutions in the transport system of the Capital Region of Denmark manage to incorporate both the bicycle and the train in its entirety as an integrated system. A strong national institution might be necessary to create a connected system and contribute to a radical transition of the transport system.

5 The Future of the Bike-train Mode

In this essay, we have taken a system approach to the bike-train mode inspired by Kager et al. (2016). Following their argument that the bike-train mode should be treated as a singular system, we have discussed how the bike-train mode can be established in an institutional context and in regard to specific system changes. However, as our study in *PART I Mobility practices of bike-train commuters* have shown the practice of commuting is not defined by one specific mode. The users do not make "rational route choices" in term of their commute as traditionally predicted for in traffic planning. They make errands on the way, bring their children to school or meet friends afterwards all, which affect the practice of commuting. This might raise the question if a new approach is needed in transport planning moving away from traditional institutions focusing on one mode of transport towards practice-based institutions encompassing the dynamics of everyday life. The current initiatives targeting bike-train commuting might not be effective without a practice approach. Following the arguments in the prior section, the construction of bicycle highways seems to resemble a certain car-logic. Merely the use of the word "highway" indicate a socio-technical system heavily influenced by the automobile. According to Te Brömmelstroet the concept of bicycle highways is a misguided notion:

> *"Planning of bicycle highways is based on a "car logic". Bikes doesn't move like the cars, a bicyclist wants to be flexible not locked on one specific route. Every lane should be in high quality instead of the focus on specific "highways". I think we need change how we talk about planning of bicycle infrastructure. We have to rethink the concept of bicycle lanes and not follow the same old ideals of road infrastructure that the car system dictates" (Te Brömmelstroet 2018).*

It was the bicycle union in the Netherlands that invented the term "Bicycle highway". According to Te Brömmelstroet this term is not a coincidence but done because people understand this car dominated language.

> *"To get the funding they need to talk this type of language and prove in a model that the infrastructure reduce congestion. But the money could be spent so much better that on bicycle highways. The concept is built on a "commuter logic" in transport planning. We build the highways specifically for commuting to work, even though it is not the majority of the trips people make. We travel much more diverse than that. We build to handle the commuting peak hours, which seems strange as you don't build 100 registers in the supermarket just because that people shop the same time in the evening" (Te Brömmelstroet 2018).*

Paradoxically, Bruggink planer of bicycle highways in Gelderland agrees with this statement;

> *"I think it is the perception of what we are doing that needs to change. If the focus is to get people out of the cars, it is not the right words to use. Freedom, health, a space to open up your mind and to forget about work and think new thoughts, more connection between people that should be the narrative. We should use the word diversification instead of limitation that will make more things possible."*

Overall, the bike-train mode is difficult to plan for as an example the typical user in the Netherlands can access more than 200 different combination trips from the city center of Amsterdam with a 20-minute bike ride (Te Brömmelstroet 2018). The future policies concerning the bike-train commuting should be based on how people experience different types of modes and routes. Future studies need to investigate why people choose the route they do further. Our study indicates that stations with the direct train connection, high frequency or faster types of public transport modes is key in the choice of a route. But, when station areas overlap providing many route choices how do people then decide which stations they bike to?

Our findings of the user analysis indicate that a bike-train organization must, to some extent, be reinvented to provide other things than just infrastructural aspects. It is crucial that the infrastructure accommodates the bike-train commuters both around public transport hubs but also on the bike lanes. However, we also discovered that it requires a higher level of skills to combine bike-train, both in terms of the everyday life but also on the actual commute. Mobility counselling,

where bike-train commuters can inspire others, help potential bike-train commuters to acquire the competences needed to fit in the bike-train commute is most likely need if the practice of bike-train commuting is to be upscaled and established as a new dominant socio-technical system.

Provelo is a Belgian association that works with providing mobility counselling to people or to businesses. Their overarching goal is to promote cycling, and they work with bringing the joy into the bike journey, offering for instance 'cycling buddies' where people can sign to get accompanied by experienced cyclist on new routes to and from work for example (Provelo 2018). They educate 'mobility advisors' to advice people or work places who wants to bike more in their everyday life, this could be in terms of advice on getting a new bike or advice on different kinds of route choices. Provelo has around 80 employees compared to SCS of the Capital Region of Denmark who are five people (Viellin 2018).

Interventions such as mobility counselling or a cycling buddy might immediately seem to have limited effects, but Watson (2012) argues that if the small practice interventions and initiatives can create momentum, they hold the potential of having substantial impact on the overall system.

"[…]through a gathering momentum of relatively soft changes around cycling, it could become sufficiently normal and legitimate as a mode of urban transport that priorities of road design and even the formal rules of the road are fundamentally shifted" (Watson 2012: 495). The bike-train mode emerged as a bottom up system, have influenced the changes in bicycle infrastructure, and have been embedded in transport policy (Te Brömmelstroet 2018). By recruiting these practices, it is possible to change the system, of which these practices is a part. Examples as Provelo offers another approach to the upscaling of bike-train commuting. By helping to embody cycling practices, they help the recruitment of sustainable practices. Watson (2012) argue that this approach to policy enable changes in the infrastructures, rules and institutions in the socio-technical system. This argument might seem in opposition to Kager et al. (2016) who argue for changes on a system level. However based on our findings both is necessary in a sustainable transition.

CONCLUSION

Conclusion

In this thesis, we examine bike-train commuting in the Capital Region of Denmark as a potential alternative mode of transportation to car based mobility. The study has been instigated in a collaboration between the *Sustainable Cities* program at Aalborg University and the Cycle Superhighway Secretariat. The aim of the study is to investigate the following research question;

How can bike-train commuting be supported and contribute to a sustainable transition of the transport system in the Capital Region of Denmark?

In the conclusion, we will present and reflect on the mobility practices of the bike-train commuters, the tensions in the current bike-train practices and policy interventions to counteract them, and finally which institution we consider should support the bike-train mode in a sustainable transition.

Despite the similarities in meanings, materials and skills bike-train commuters share with other groups of bicyclists, and public transport commuters our research suggest that the combination of bicycle and train produces unique mobility practices of its own. Distinct elements are required to produce the practice; special materials in places of transit such as bicycle compartments in the train, competences such as being able to navigate in the public transport network by bicycle, and meanings associated with bike-train commute describes getting the best of both worlds. Applying a practice perspective allow us to gain knowledge of the complexity of the bike-train commuting practice. Numerous compositions of the two modes exists requiring different elements to produce the practice. However, the main insight of our study of bike-train commuting is the existence of two distinctive mobility practices, which seem determined by the distance the user cycle on his or her daily commute.

The bike-train commuters cycling long distances (>15 km) attribute their commute with exercise and mindfulness. They have extensive skills in term of navigating the bicycle lane network and public transport system, as they choose different combination routes from day to day or season to season. Furthermore, they are dependent on materials such as the bicycle compartment on the train, as the combination of modes allow them to cycle the entire way in one direction and bring the bicycle on the train while restituting the other way. Bike-train commuters cycling short distances (<15 km) a day attach the meaning of time productivity and flexibility to their commute, their practice might require an old bicycle that they dare leave at the station, and they rely on time table delay apps to a greater extent. The different materials, competences and meanings enabling short or long cycling distances on the bike-train commute is crucial in the discussion of how we plan and design for the bike-train mode. The existence of different bike-train mobility patterns has numerous implications in regard to how the mode should be supported in a sustainable transition.

In order to fulfill the potential of the bike-train mode in the Capital Region of Denmark and recraft or substitute unsustainable mobility patterns, an addition to the concepts of the current Cycle Superhighways is needed. Our results indicate that the bike-train commuters cycling long distances make use of the current routes running along the rail when they cycle the entire way in one direction. However, to recraft practices and increase the catchment area of the stations the bicycle infrastructure should also improve conditions for the commuters cycling shorter distances. In a sustainable transition perspective, it is crucial that the bicycle does not compete with public transport, but with the car. To establish attractive bicycle infrastructure in corridors, where the train offers a faster transportation option, target dedicated bike-train commuters cycling long distances and might compete with the train for passengers. Whereas, improving the overall bicycle infrastructure in the catchment area of a station, will improve conditions for all bike-train commuters and might increase the catchment area of the station. The bicycle highway must therefore have a double function. It should both lead the commuter to stations, and at the same time, enable commuters to cycle fast and far. We therefore suggest adding two additional functions to the concept of Cycle Superhighways in the capital region 1) guiding the bike-train commuter to one or more stations and 2) ensuring a frictionless trip from departure to transit.

Our study suggests that the frequency and different modes at a station can determine route choice. However, we are also aware that interlocking practices is affecting the user groups commuting patterns and routes choices. Future research should investigate how bike-train commuters choose their route to the station to design better and attractive routes, which can widen the catchment area and support the mode further.

Drawing on a transition perspective, we argue that to maintain and upscale a sustainable practice is just as important as trying to change an unsustainable one. Our findings suggest that tensions often arise in the bike-train practice when the users experience capacity problems in the train. The ability to relax or work in the train disappears in peak hours especially for the ones bringing their bicycle onto the train. The ability to bring the bicycle on the train is crucial in maintaining the bike-train commuter cycling long distances. However, capacity issues are pressuring the current system and to be able to upscale bike-train commuting a new system design is needed. Our study suggest that different types of commuters bring their bicycle on the train; users who cycle long distances and users who cover last miles. Different incentives might encourage the bike-train commuters bringing their bicycle to cover last mile distances to opt to other options than bringing their bike onto the train. An example could be a regional or even national station bicycle scheme which offers a wide variety of bikes to satisfy the different user needs. This would reduce the tension the users experience in the trains as they would no longer *need* to bring their bike along and the variety of bikes would provide the users with many options, thus increasing their flexibility. Another option to address capacity issues might be a reform of the ticket system that could motivate bike-train users

cycling short distances to stop bringing their bicycle on the train and encourage more cycling in general. The current ticket system is problematic as the monthly paid commuter pass seem to result in a replacement of bicycle trips in the commuter's leisure time. If bike-train commuting is to contribute to a sustainable transition, a ticket reform should ensure that bicycle trips are not replaced with public transport. Overall, further research of how bicycles on trains can be upscaled is necessary to be able to maintain the segment of bike-train users cycling long distances.

Transport policies are, to some extent, already trying to address some of the current tension that we have identified in this study of bike-train commuter practices. Trialability projects trying to get people to cycle longer and embody new practices, development of navigation apps that help commuters find new routes, station bicycles to cover last miles, bicycle highways improving the conditions for long-distance commuters, and bicycle campaigns promoting health and community at work places are just some of the examples of the current initiatives trying to recraft or substitute practices. However, despite the last 40 years attention on bike-train trips, our station area analysis revealed critical conditions for bike-train commuting, especially low-quality bicycle parking and poor accessibility. Secure bicycle parking racks allowing users with expensive bicycles such as families with cargo bicycles or commuters with racing bicycles to combine modes is still not available at the stations. Even in brand new bicycle parking facilities, only standardized parking racks are installed. As a result, the commuters who park at the station feel they have to cycle on a "havelåge" (a rusty old bicycle) to avoid theft. Furthermore, uninspiring waiting areas and missing links in the infrastructure between the bicycle highway, station access routes, the bicycle parking, and the platform mark the areas. In general, our findings suggest that to support the bike-train mode we need a system approach to bike-train policy instead of stand-alone interventions. When different transport institutions with different level of authority are trying to promote different parts of the bike-train system the infrastructure becomes fragmented. Inspired by the transition trajectory of the Danish road network one might argue that the bike-train mode needs to be institutionalized in a national agency able to connect the missing links. The current institutional set up makes it difficult to ensure the flow from the bicycle path to the boarding of the train. As long as DSB is responsible for the design of the stations and municipalities is responsible for the surroundings missing links between stations and their surroundings might continue to occur.

However, when applying a practice perspective, we find that commuter patterns among the group are more complex and encompass more than just "bike-train commuting". Overarching societal structures influence and increase the complexity of the mobility patterns of bike-train commuters. 37%-56% of the user group does not combine bike and train every day and during a typical week 65% combine daily while 35% travel all the way on bicycle, with car, public transport, or work from home. The combination of bike and train might change from day to day or from season to season. The opportunity to combine modes is often facilitated by changes in interlocking practices such as the possibility of flextime, flexible opening hours in the daycare and getting groceries delivered. We

propose an increased flexibility in these interlocking practices as that would allow more potential users to perform the bike-train commuting practice. With this in mind, transport policy need to be reconfigured to support the bike-train commuting as the proposed elements of interventions involve different levels of planning agencies and different sectors. This might argue for a completely different approach to transport planning moving beyond traditional planning agencies viewing the transport practice of commuting as a whole and gathered in an institution coordinating across the modes. The ability to coordinate between different transport sectors instead of each institution fighting for space and funding seem imperative as our study suggest that car parking fees and congestion is supporting the bike-train mode as much as bicycle compartments on trains and bicycle routes.

Our findings suggest that to substitute the car with bike-train commuting and contribute to a sustainable transition, two things matter 1) supporting the bike-train mode and 2) limiting the car. How these initiatives can be done simultaneously to enable a transition and how such a scheme can be designed is a topic of further research.

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Appendix I

The setup of measurable parameters is made in accordance with a point system. We have investigated the nine selected stations by visiting them. The score system is developed in such a way that if a parameter has met the criterion, points have been awarded. Besides observing and testing specific parameters, we made general observations of the stations, their surroundings and the people who spend time there, those who arrived and those who left the station. The observation as a qualitative method gave us a general impression of the station and how people who uses it, which is a simple but very rewarding (Rasmussen et al. 2006). We documented these observations with a series of pictures. We also used observation as a quantitative method, when counting as stations.

Before we visited the sites, we investigated all bike paths and other access roads leading up to the station. We investigated and mapped where the nearby Cycle Superhighway was located so it was easier to navigate in the area. We brought aerial photographs of the station, of the area, which the station is, a part, in order to have the context in mind when we investigated the area. The maps were used to mark when we experienced or observed something problematic for the bike-train commuters. We brought camera, maps, pens for field notes and documentation and our own bicycle, which enables us to study the access to a station for instance as it takes place – in situ – when it is performed. We made field notes, to ensure a systemic account of what we observed and reflections when observing at the stations (Rasmussen et al. 2006).

Background and methods for setting up the five parameters

Based on best practice and our qualitative and quantitative data five significant parameters has been set up to evaluate potential hubs with special focus on promoting conditions for Bike-train commuters.

STATION ENVIRONMENT

This parameter is based on our interview respondents' stories about their commute. In these stories, it became clear that the commute is one full experience, and it is important to ensure good sense impressions both on the bike path, on the train and on the station. Through our conducted interviews with the bike-train users it became evident that these sense impression is something that they notice and affect their travel to work. One respondents mentions: *"There is a sad smell in one end of the station, but in the other end there is a small rainwater garden, which I often bike through, because it is cute and cosy with birds and nice flowers."* (Bike-train commuter)

Another respondent value design elements such as special lighting details: *"If I should mention one station that has impressed me in a very simple way, it is Sydhavn Station with the sanitation they did recently. It is especially the blue LEDs hanging under the bridge. When I walk under the bridge it makes me think, wow this is cool. Before, it was really just a dark concrete bridge, but now it is a bit more open and modern with cool urban lighting"* (Bike-train commuter)

Another respondent emphasizes the importance of the waiting time value, with the fact that the station has something to offer. *"Malmparken Station is a rather annoying station, it is just a step board, boring and unexciting. There are really many stairs climb, and when you get up it is just ugly, old and worn down.*

Ballerup Station just seems more open and nice, because there is more urban life and the station feels open. Malmparken Station is just two tracks and that's it, - there is just nothing. While at Ballerup Station, there is a 7-elleven and there is domino's pizza. It's more open" (Bike-train commuter)

Findings of the bike-train commuter analysis has been supplemented by literature studies in order to set up and qualify specific criteria. The identified factors for the station environment that are of importance to the bike-train commuters, we used Jan Gehl's 12 Quality Criteria for urban spaces. The 12 criteria tool is used to research the user experiences of public spaces by setting up 12 criteria evaluate different characteristics of a given public space, in our case the station area. The purpose is to evaluate whether the features are protective, comfortable, and enjoyable for people who spend time there (Gehl 2010). These criteria has been used to flesh out which measurable parameters that refers to the identified indicator. A table of the listed indicators and the related measurable parameters is shown below.

Indicator		Measurable parameters
Sense impressions	General nice pleasant feeling, appealing to senses	➢ No trash outside of trash cans ➢ No graffiti ➢ No smells ➢ No loud noises
	Safety	➢ Platforms completely lit ➢ Access points completely lit ➢ Bus stops completely lit
	Openness of station	➢ Unhindered optic lines ➢ Open air
Waiting time value	Valuable wait	➢ Interesting view from platform such as advertisement screens, urban life or greenery.
	Smaller Shops	➢ One or more shops located by the platforms in connection with the station
	Shelter on platform at departure station	➢ Roof to protect against weather on every platform ➢ Roof to protect against weather on every bus stop
	Possibilities for relaxation	➢ Benches and inviting facades to lean on at every platform and bus stop ➢ Benches to relax while waiting at every bus stops
	Urban life/activities	➢ Restaurants, playground or outdoor facilities to sit/stay or play 100 meters from station
	Aesthetic surroundings	➢ Design with extra details, art exhibition, greenery, lighting etc.

Method

In order to assign scores of station environment we made observations in bright daylight and dark hours in order for us to assess the safety according to level of lighting at the station areas. We chose to asses at score of safety based on the fact that there is lighting, this method can be questioned and it would have been preferable to back the observation up by individual interviews with people staying and passing by the station both during night and day. We investigated the station and the surroundings imagining that we were the bike-train commuters. For instance we went to all platforms and from there assessed if there were interesting views such as green surroundings or no loud noises.

SERVICE LEVEL

It is important that the service level at stations is high in order to make the trip as comfortable and easy for the Bike-train commuters. We know based on the user analysis that the users value the possibility of having more transport modes to pick from. This affects the perceived connectivity and their flexibility and it also provides bike-train users with the possibility of choosing between different modes. For instance one of the bike-train commuters have a membership to Bycyklen: *"One of the reason why I appreciate Bycyklen, is the fact that I am not dependent on where I parked it the last time."* A large variety of the transport modes is preferable as this potentially can make as many bike-train users' commute as flexible as possible.

Many of the bike-train commuters are challenged by the obligations of family life, such as picking up kids and serving differ for their kids at specific hours. This fact makes it even more challenging for those bike-train commuters who bike longer distances, because it often prolong their total travel time. Others have an understanding that you can only do grocery shopping if you have a car "I take my car because then I have the opportunity to go shopping when I come home. There is no change I will go grocery shopping on my way home if I take the bicycle or the bus." (Bike-train commuter) In addition, several of the interviews respondents mention that, in order to make their daily lives add up, they receive meal boxes weekly. in order to promote the bike-train mode, it is relevant to look at the stations in a broader perspective than it has been the case so far. Peoples commute and therefore also the station at some point, is a part of the everyday practices. Based on this argument, it is relevant to assess a station's potential to support the bike-train courage based on service facilities that relate to people's daily lives and daily activities, such as grocery shopping options, fitness center or delivery boxes or GLS package. A high level of station services creates a better foundation for more waiting time value.

Indicator		Measurable parameters
Travel information	Access to travel information	➢ Electronic updated departure/arrival times in connection with all transport modes (located at access points at s-train, bus and metro) ➢ Map of operating lines by all platforms and bus stops
	Access to tickets	➢ Ticket machine in proximity to travel information
Bicycle service	Station bikes	➢ Donkey Republic ➢ Bycyklen
	Do it youself repair	➢ Bicycle pump, etc. close to the bicycle parking
	Bicycle repair shop	➢ Shop in 200 m proximity to platform
	E-bike service	➢ Charging possibilities for e-bikes
	Other services	➢ Locker for stuff/drinking fountain etc.
	Advertisement	➢ Electronic screens
	Other services	➢ Delivery boxes/ package service 7-elleven /gls kiosk
	WiFi at station	➢ Connecting to WiFi at the waiting areas
	Car sharing	➢ Car sharing parking spots, number of FF-cars in 200 m proximity
	Taxi service	➢ Taxi parking lots
	Shopping	➢ Grocery store in proximity ➢ Drugstore ➢ Other
	Newspaper	➢ Free newspaper stands at station

Daily life services	Fitness center	➢ Fitness 200 m from station

Method

We assessed the service level at stations by examining the services the station offers, but also its surrounding areas. To assess the possibility to make use of more transportation options such as car sharing, we observed if there were any assigned parking areas for car sharing vehicles, and furthermore we observed if there we any cars in close relation to the area.

BICYCLE PARKING

The indicators are based on the CSS questionnaire, the conducted interviews with bike train commuters and literature studies of best practice using "Cykelparkeringshåndbog", which is a guide to proper bicycle parking and bicycle infrastructure.
55 % of the respondents of the CSS survey[1], whishes improved bicycle parking at stations. Despite many efforts for decades, there is still a great need to improve conditions for those who park their bikes at a station. The Municipality of Copenhagen's Prioritization Plan *for Bicycle Parking 2018-2025*[2], confirms this fact, which according to future predictions, determines inadequate conditions at many stations. This means that many stations in Copenhagen will be subject to a transformation in regard to the bicycle parking. Many stations must therefore improve the existing parking conditions as well as increasing the number of parking spaces. This gives rise to a new thinking in the field of bicycle parking, and hopefully this document can help inspire to solutions that accommodate the needs of bicycle-train commuters.

Bicycle parking in general seems to could have the largest impact on the interviewees perception of what they think could enhance their combination trip. We discovered two aspects that matters to the bike-train commuters; the bicycle parking itself and the location of the bicycle parking.

According to "Cykelparkeringshåndbog" it important that there are enough and sufficient bicycle parking at stations. We therefore went out to map the rate of occupation, the location of the bicycle parking areas at the different stations and the bicycles parked outside of the designated racks, as it is often a result of either too few parking spaces or inappropriate location of the parking spaces. (Dansk Cyklist Forbund 2007).

Among the bike-train users who park their bicycle at stations the two factors that seems to be most important are close proximity to train and security. Several interviewees mention the risk of having their bike stolen as a barrier to park their bicycle at the station. *"I park my bike where is can attach it to something"*(bike-train commuter), while sheltered bike parking facilities also is mentioned to be preferred (interviews with bike-train commuters). This fact it further enhanced by the fact that our interviews revealed that some of the long-distance bike-train commuters have bicycles that are more expensive. However, another study has found that security of the bicycle is an even bigger concern for the people who does not already bike[3], which means that it is extremely important to ensure high standards of bicycle parking where people feel secure and that they are actually designed to lock the bicycle frame to something. This sense of security is further enhanced by the possibility of locked bicycle parking, proper lighting and clear video surveillance of the parking area.

The bicycle parking at stations must meet the variety we see in the overall bicycle fleet, for instance 25% of all families with children in Copenhagen owns a cargo bike, which makes it highly relevant to measure on the parameter for special bikes. Entrance to the parking area, must be at least 2.0 m wide in order for two bicycles to pass each other - even when they are pulled. Dansk (Cyklist Forbund 2007).

[1] CSS questionnaire 2018, ultimately based on bike-train commuters
[2] Prioriteringsplan for cykelparkering 2012-2025
[3] Movia 2017 - Superskiftet

Indicator	Measurable parameter
Sufficient number of parking spaces	➢ Occupation rate less than 90% and more 80 % in peak hours
Proximity to platform	➢ Less than 5 % of the bikes parked outside of the parking area* ➢ Are all parking facilities less than 50 m away from station?
Secure parking facilities	➢ Access to locked bike parking ➢ Access to parking where a bike can be secured with a chain ➢ Surveillance cameras in parking area (minimum one area)
Sheltered parking	➢ Access to sheltered bicycle parking
Parking for special bikes	➢ Extra room for cargo bikes or other special bikes
Travel information	➢ Travel information in close proximity to bike parking (can you get information from bike parking)
Access to bike parking	➢ Bike path in connection with parking facility ➢ No sharp or steep access points (curb) ➢ A minimum 2 m wide stair/access point with ramps if in other level
Signage	➢ Signage leading from the bicycle path entries to the parking space
Flow	➢ Short distance from platform to bicycle parking (1-2 minutes)
Order and cleanliness	➢ Disused or abandoned bicycles
Safety	➢ Lighting
Aesthetics	➢ Special design features at the parking area

Method

We went out to inspect the different stations in a time span of 2 hours – from 10.00-12.00 am in the late morning hours. This choice was made as the time span allowed us to measure the occupation rate of the bicycle parking (Dansk Cyklist Forbund 2007). However, this choice of time span is also a descent of the rush hour that for many stations is between 07.30-08.30 am. At this time where it would have been interesting and relevant to observe how the bike-train commuters behave when arriving or departing the station and for instance measure the time it takes for people to find a parking space or to get from the bicycle parking/bicycle lanes to the train. However, there were still passengers arriving and departing the station between 10-12.00 am, which made it possible anyway. We used observation as a quantitative method, when determining whether the existing parking spaces and their locating was sufficient and correct. The account of bicycles parked outside of racks, is a reasonable method to evaluate if the parking is placed correctly according to the access routes and the platform (Dansk Cyklist Forbund 2007). We set a marginal value for the percentage of how many bicycles outside of designated racks and the occupation rate, both inspired by experiences of the "Cykelparkeringshåndbog".

Our visits at the station consisted of mixing methods of counting, observing and timekeeping, which were either marked on a map of the area, listed in a table or documented with photographs. The maximum acceptable distance to bicycle parking for bike-train commuters is 50 meters (Cykelparkeringshåndbog), but as we have shown in the user analysis, the perspective of a bike-train commuter it makes more sense to measure this distance in time and not meters, because time is of most importance. Therefore, we measured the time it took for passengers to move from the bicycle parking to the platform, in order to

determine whether the parking facility should have a score or not. The acceptable time was decided to be less than 1 min to the platform.

Based on the literature study of the quality of the bicycle parking, we discovered that it possible to make a ranking among the different types of bicycle parking. This could have provided our analysis of the bicycle parking with more nuanced as we would have been able to value the different standards. This fact is supported by our interview respondents who expresses different preferences in regard to the bicycle parking.
When counting bicycle parking systematic field notes is recommend over several days and in different weather. This was deselected due to time limiting factors, but it could certainly have given a more reliable account of the occupation rate for instance.

ACCESS AND EGRESS

The indicators are based on the CSS questionnaire and the conducted interviews with bike train commuters. 44% of the respondents in the CSS questionnaire answer that electronic ramps for bicycles on stairs, would enhance their bike-train commute. At the same time, stairs at the stations and shifting transport modes related aspects provoke resentment among the commuters. It is especially the women who wish better opportunities to transport, their bike up and down stairs such as electric escalators or ramps(CSS questionnaire), while the majority of the men just carry it on their shoulders(Interviews with bike-train commuter), which calls for wide stairs. This means that access to and from the platform for those who bring their bicycles on the train is important when designing for bicycle-train commuters.

Closeness to platform:
Opinions that *"I can bike almost right into the train"* (bike-train commuter) and *"I can jump on the bike as soon as I get out of the train"* bike-train commuter) is highlighted as very positive things by the interviewees who bring their bike on the train, when explaining every step of the bike-train combination trip.

The flow of the bike-train commute is crucial, the longer they can sit on their bike the better, and the faster they can jump on their bike the better. More access and egress points to the platforms of the stations ensures a better possibility to choose the closest access or egress point according to the errand.

Indicator	Measurable parameter
Ramps for bikes	➢ Ramps by all platforms ➢ Ramps (both ways) to all platforms
Elevator	➢ Elevator by all platforms
Wide stairs	➢ Are all stairs to the platforms 2 m wide?
Exits	➢ Are there platforms with multiple/several exits?
Flow	➢ Does it take less than 1-2 minutes to get to/from the platform to the bike path away from the station ➢ Does all the bike paths connect with the station area? (map problematic missing links) ➢ Is the majority of the platforms level to the bike path
Signage	➢ Signage to/from the station to the SCS
Travel information	➢ Travel information by ramps/elevators or other cyclist access points

Method

In order to measure the parameters relating to access and egress, we observed the features at the stations, such as the stairs and the exist points. Furthermore, we used measuring tape, stopwatch, cameras for photos series and our own bicycles. The guidelines of the best practice of access and egress for bicyclists, operate in meters, were we argue that it is more relevant to measure in time. The argument for this is that a short distance in meters not always is an indicator of good connections, as is can still interrupt the flow of the bike-train commuters. We tried to arrive by bike to the station of all access roads, in order to experience the barriers and obstacles on the way to the station. This method was repeated from the train on the platform and to the access road and from the access road to the platform.

BIKE LANES

No matter whether the bike-train commuters cycle 15 km or 2 km to the station, the bicycle infrastructure is an important factor. Studies from both the Netherlands[4] and Denmark[5] show that there is a correlation between the distance the bicyclists are willing to bike on their everyday commute and conditions of the bike lane such as, traffic lights, designated bike lanes separated from other traffic, or routes with a green backdrop. The more interruptions on the way to the station, the shorter distance is the cycling catchment area of the station. Better cycling infrastructure to and from the station can therefore encourage more to cycle further on the bike-train commute.

The two surveys suggest that the bike-train commuters compared to the general commuter are more likely to perceive better bicycle infrastructure as a motivating factors that could encourage them to bike more. Some value the direct, straight forward bike lanes, while other appreciate exciting and scenic routes.

Indicator		Measurable parameter
	Separation from other traffic	➢ Separated bike lanes with a curb to or from the bicycle highway
	Surface state	➢ Asphalted bike lanes without holes to and from the bicycle highway
	Lighting	➢ Lit bike lanes to and from station and the bicycle highway
	Continuous paths	➢ No traffic lights/intersection to and from station to the bicycle highway
	Scenic route	➢ Greenery or urban environment on the path to and from the station to the bicycle highway
	Flow	➢ No obstacles that forces one to stop or sidestep when cycling to and from the bicycle highway
	Access routes to station	➢ Several routes from the station to the bicycle highway
	Measure of bike lane	➢ At least 1,7 meter wide

Method

Before visiting the stations, we mapped the Cycle Superhighways on a map, to make it easier to navigate in unfamiliar surroundings. In order to evaluate the flow from the Cycle Superhighway to the transit (station area), we mainly used auto ethnographic method biking and experiencing the routes ourselves. This method allow us to participate in the flows and the movements of people arriving at stations by bike, or connecting to the Cycle Superhighway close to the station (Larsen 2014). Bringing our own bicycle, made us able to distance ourselves from the researcher position we had when we walked around the station counting and taking notes. The bike made us in a way blend in at we were able to let our emotions and feelings to be in focus when we experienced how it was to arrive that the station, and how it was to connect to the Cycle Superhighway.

Some of the stations have several routes to and from the Cycle Superhighway, and if they fell short on one parameter they were not assign a score.

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