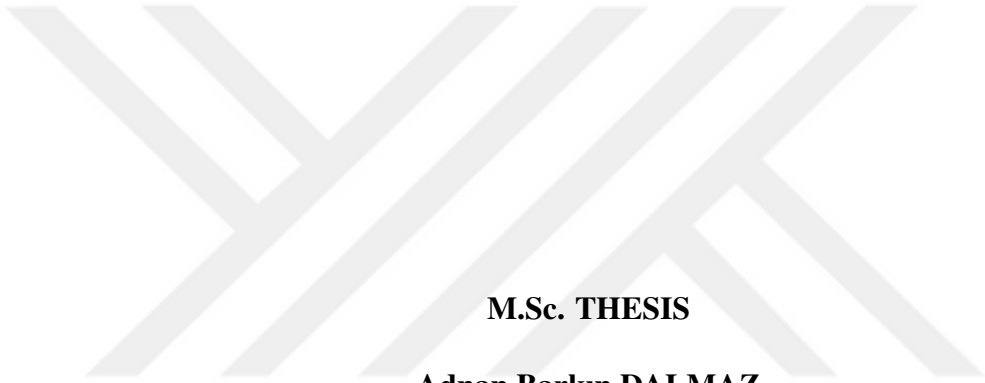


**STRATEGIES FOR INCREASING URBAN CYCLING
THE CASE OF GOTHENBURG**



M.Sc. THESIS

Adnan Barkın DALMAZ

**Department of Civil Engineering
Transportation Engineering Programme**

SEPTEMBER 2017

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**Adnan Barkın DALMAZ
(501131401)**

Department of Civil Engineering

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Thesis Advisor: Prof. Dr. Zübeyde Öztürk

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**KENTİÇİ BİSİKLET ULAŞIMINI ARTTIRMAYA YÖNELİK STRATEJİLER
İSVEÇ, GÖTEBORG ÖRNEĞİ**

YÜKSEK LİSANS TEZİ

**Adnan Barkın DALMAZ
(501131401)**

İnşaat Mühendisliği Anabilim Dalı

Ulaştırma Mühendisliği Programı

Tez Danışmanı: Prof. Dr. Zübeyde Öztürk

EYLÜL 2017

Adnan Barkın DALMAZ, a M.Sc. student of ITU Graduate School of Science Engineering and Technology 501131401 successfully defended the thesis entitled “STRATEGIES FOR INCREASING URBAN CYCLING THE CASE OF GOTHENBURG”, which he/she prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

Thesis Advisor : **Prof. Dr. Zübeyde Öztürk**
Istanbul Technical University

Jury Members : **Prof. Dr. Zübeyde ÖZTÜRK**
Istanbul Technical University

Doç. Dr. Murat ERGÜN
Istanbul Technical University

Yrd. Doç. Dr. Güzin AKYILDIZ ALÇURA
Yıldız Technical University

Date of Submission : **25 August 2017**

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September 2017

Adnan Barkın DALMAZ
(Environmental Engineer)



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ABBREVIATIONS

AM	active mobility	40
C-Lab	Challenge Lab	1
e-bike	electric bike	70
EU	European Union	2
EV	electric vehicle	92
GHG	Greenhouse Gases	2
LP	leverage point	18
MaaS	Mobility as a Service	109
MDM	Multilevel Design Model	43
MoT	modes of transportation	29
OM	Operation and maintenance	106
PT	public transportation	39
RVU	Resvaneundersökningen - Swedish travel survey	88
SDG	Sustainable Development Goals	12
SEK	Swedish Krona	63
UN	United Nations	2
VGR	Västra Götalandsregionen	5



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STRATEGIES FOR INCREASING URBAN CYCLING THE CASE OF GOTHENBURG

SUMMARY

As the world is experiencing a fast-paced urbanisation, the demand for urban mobility is increasing. This raises the question of how to organise a functioning transportation system. The elements of such a system include a combination of public transportation services, active mobility solutions such as walking and cycling, and personal vehicles. To assess the performance of a transport system, ecological, economical, societal, and well-being criteria can be applied. The purpose of this thesis is to provide guidelines for scaling up the modal share of cycling in Gothenburg area. To pursue this goal, the impacts of cycling regarding the aforementioned criteria are investigated and a framework to increase its modal share is provided. This is supported by the following research questions:

- *In which cases does cycling pose an advantage for the users over other modes of transportation?*
- *What are the potential barriers and drivers for scaling up cycling?*
 - *Where are they located in the multilevel design model and how do they influence each other?*
- *Which initiatives need to be taken in order to support the intention of up-scaling cycling?*

Under the methodological umbrella of backcasting and the multilevel design model, the following research activities are executed; literature review on urban transportation, quantitative analysis of travel statistics, interviews with end users who cycle as their main mode of transportation (or are considering it), and lastly a co-creative solution development with mobility professionals.

The results of the research activities include the criteria for future urban mobility, impacts of cycling on the aforementioned criteria, the extents of potential target groups; barriers and drivers for a transition towards cycling as part of active mobility; as well as a plan providing concrete actions to be performed in order to ensure this process.

The results are designed to assist the implementation of the Gothenburg cycling strategy for 2025. In conclusion, three different areas need to be looked into to increase the number of cyclists and the modal share of cycling: Firstly, focusing on communicating the advantages of cycling, in particular the positive impacts on the physical and mental well-being. Secondly, lowering the entry threshold for non-cyclists in order to enable them to experience the positive effects and support a shift from other modes of transportation towards cycling. Last but not least, making sure that cycling remains convenient for those who are using this mode of transportation by providing suitable infrastructure.

Keywords: Cycling, active mobility, zero-emission, urban mobility, sustainability, backcasting, multilevel design model, triple-helix, Challenge Lab



KENTİÇİ BİSİKLET ULAŞIMINI ARTTIRMAYA YÖNELİK STRATEJİLER İSVEÇ, GÖTEBORG ÖRNEĞİ

ÖZET

Tüm dünyada kentleşme hızla ilerler ve kentiçi ulaşım talebi de buna paralel olarak hızla artarken; bu talebi karşılamak için farklı kentiçi ulaşım çözümleri, planlama ofisleri tarafından planlanmakta ve uygulamaya konmaktadır. Bu bağlamda çözülmesi gereken sorunlar arasında, verimli bir ulaşım sisteminin organizasyonu öne çıkmaktadır. Böyle bir sistemin, yerel koşullara göre; toplu taşıma çözümleri, yaya ve bisiklet olmak üzere aktif ulaşım sistemleri ve kişisel taşıt unsurlarını içermesi beklenir. "Chalmers Areas of Advance" bünyesinde 2014 yılında kurulmuş olan "Challenge Lab" sürdürülebilirlik dönüşüm platformu çerçevesinde, sistemlerin performans değerlendirmesi için çevresel, ekonomik, toplumsal ve refah kriterleri ele alınmaktadır. Bu tez kapsamında, öncelikle bisiklet kullanımının etkileri, belirtilen kriterler kapsamında ele alınarak değerlendirilmiş, ardından diğer ulaşım sistemleri arasında kullanım payını arttırmak adına bir çerçeve oluşturulmuştur. Bunu desteklemek adına aşağıdaki sorular irdelenmiştir:

- *Bisiklet kullanımı, diğer ulaşım sistemlerine göre, kullanıcılara herhangi bir avantaj sağlamakta mıdır?*
- *Bisiklet kullanımını arttırmak için olası destekleyici ve engelleyici unsurlar nelerdir?*
 - *Bu unsurlar "Çoklukatman tasarım modeli"nin hangi katmanlarında yer almaktadır ve birbirlerini nasıl etkilemektedirler?*
- *Bisiklet kullanımını arttırma maksadıyla, hangi girişimlerde bulunulması gerekmektedir?*

"Backcasting" metodolojisinin ve "Çoklukatman tasarım modeli"nin çatısı altında, belirtilen araştırma faaliyetleri gerçekleştirilmiştir:

- Kentiçi ulaşım hakkında gerekli literatür çalışması
- Bölgesel yolculuk istatistiklerinin nicel incelenmesi
- Bisikleti ana ulaşım modu olarak tercih eden ya da buna geçiş yapmayı düşünen son kullanıcılarla mülakatlar
- Ulaşım uzmanları ile çözüm odaklı beraber oluşturma çalışmaları

Bilgi kaynakları

Literatür taraması haricinde dört tip bilgi kaynağı kullanılmıştır. Yolculuk envanterinin istatistiki analizi yapılarak hangi grupların çalışmalarda hedef alınacağı saptandı. Bisiklet ulaşımının avantaj ve dezavantajlarını, buna ek olarak bisiklet kullanıcılarının karşılaştıkları zorlukları tesbit etmek üzere, söz konusu grup ile son kullanıcı mülakatları yapıldı. Süregelen projeleri araştırmak için konunun uzmanları ile mülakatlar yapıldı. Son olarak, beraber çözüm teklifleri oluşturmak adına, elde edilen veriler derlenerek, bizim tarafımızdan düzenlenen tasarım atölyesinde sivil toplum, kamu ve özel sektörden paydaşlarla paylaşıldı.

Elde edilen sonuçlar

Bireysel taşıt ya da toplu taşıma ile yapılan yolculukların büyük bir kısmı yaya yolculuğu ile başlamakta ya da bitmektedir. Bu durumun, sözkonusu ulaşım türlerinin hız avantajını büyük oranda etkilediği sonucuna ulaşılmıştır. Aktif ulaşım türleri olan yaya ve bisiklet yolculuklarının avantajı bu noktada, park etme ya da istasyonlara ulaşma yolculuğundan bağımsız oluşuyla önem kazanmaktadır.

Modal dağılımın analizi ile elde edilen sonuçlar aşağıda sıralanmıştır. Bu veriler incelenirken gözardı edilmemesi gereken bir nokta, yolculukların 24 saat esasına göre kaydedildiği ve başlangıç-bitiş noktalarının aynı nokta olmasıdır.

- **0-5km arası:** Yolculukların büyük kısmı yaya yolculuğu kategorisinde, geriye kalan yolculuklar da tesbit edildiği kadarıyla gündelik işleri organize etmek ya da çocukların okula bırakılması- alınması şeklinde. Bu yolculuklar kargo bisikleti ile gerçekleştirilebilir.
- **5-10km arası:** Özel taşıtlarla yapılan yolculuklar kargo bisikleti ya da konvansiyonel bisiklet ile gerçekleştirilebilir.
- **10-20km arası:** Yolculukların büyük çoğunluğu özel araçla yapılmakta. Yeni başlayan bisiklet kullanıcıları için bu yolculuklar elektrikli bisiklet ile gerçekleştirilebilir. Uzun süredir bisiklet kullananlar için ise 10km zaten ortalama günlük işe gidiş-dönüş mesafesi olarak kabul edilebilir dilimde.
- **20-100km arası:** Uzun mesafe yolculukları için tavsiye edilen strateji, toplu taşıma - bisiklet entegrasyonu ile ilk ve son kilometre yolculuklarını da özel araçla yapmaktan caydırıcı bir ortamın oluşturulmasıdır. Eğer sera gazı salınımının azaltılması hedefleniyorsa, bunun gerçekleştirilmesi bisiklet ve toplu taşımanın yaygınlaştırılması ile mümkün olabilir.

Metodoloji

Takip edilen metodolojilerden "Backcasting" in "forecasting" den farkı, gelecekte tesbit edilen bir başlangıç noktasından başlamak suretiyle, halihazırda bulunan sürdürülemez çözümlerin ilk tasarı aşamasında etkisini en aza indirmektir. İlk aşamada arzu edilen gelecek durum tesbit edilir (1). Sonraki aşamalarda gelecek ve şimdiki durum arasındaki farklar irdelenir (2), gelecek durumdaki teknik çözümler tasarlanır (3) ve arzu edilen geleceği bugüne bağlamak için stratejiler oluşturulur (4).

Çokluseviye tasarım modeli "Multilevel Design Model" esas olarak 4 inovasyon sistemini dikkate alır. Bunlar en üst kademededen başlayarak:

Toplumsal sistem "Societal system": Bisiklet sürme ve bisiklet kullanıcılarının toplum tarafından meşruiyetinin kabulü, hırsızlık ve bisiklet eğitimi gibi konular,

Sosyo-teknik sistem "Socio-technical system": Kural koyucular tarafından tesbit edilen düzenlemeler ve teşvikler, altyapı yatırımları, "try-a-bike" programları ve vergi iadesi gibi konular,

Ürün-hizmetler sistemi "Product-service system": Bisiklet altyapısı; bisiklet yolları, park alanları ve hatta ulaşılabilen dağıtımıcılar, satıcılar, bakım-onarım hizmetleri ve sigorta gibi konular,

Ürün-teknoloji sistemi "Product-technology system": Farklı bisiklet, giyim vb. teknik çözümler.

Paydaş diyalogları

Challenge Lab değişim ajanı olarak sürdürülebilirlik dönüşümünü sağlamak adına akademi, kamu ve özel sektör arası paydaş diyaloglarına uygun ortam hazırlamaktadır. Konuyla ilgisi bulunan paydaşlar tesbit edilerek bu kapsamda organize edilen atölye ile ulaşım problemleri ve bunlarla ilgili çözümler masaya yatırılmıştır.

Araştırma çalışmalarının sonuçları; kentsel ulaşım için sürdürülebilirlik kriterlerinin saptanması, bisiklet kullanımının bu kriterlerle bağdaşımının irdelenmesi, potansiyel hedef grupların saptanması, aktif ulaşım türlerinden biri olarak bisiklet ulaşımına geçişi kolaylaştıran ve zorlaştıran etmenler; ve bu prosesi gerçekleştirmek için gerekli hamleleri içeren yol haritasını sunmaktadır.

Bu sonuçlar, Göteborg bisiklet ulaşımı stratejik planına yardımcı olacak üzere değerlendirilmiştir. Bu tezle birlikte Üçlü heliks "Triple helix"ten elde edilen bilgilerin topluma arzı ve yerel olarak uygulanması ile bisiklet kullanımının arttırılacağı saptanmıştır. Sonuç olarak bisiklet sürücülerinin sayıca artması ve bisikletin modal dağılımının artması için üç temel alanın incelenmesi gerekmektedir. Bunlardan ilki, bisiklet kullanımının getirilerinin sunumuna -özellikle fiziksel ve zihinsel sağlık olmak üzere- odaklanmaktır. Bunun yanı sıra, bisiklet kullanmayanların da bu etkilerden faydalanabilmesi için, sisteme giriş eşiğinin aşağıya çekilmesi, ve son olarak bisiklet kullanımının elverişli olmaya devam etmesi için uygun altyapının sağlanmasıdır.



1. INTRODUCTION

Sustainability challenges, urbanisation, and future mobility solutions are topics guiding this master's thesis. This chapter provides the reader with background information to understand the research undertaken and explains the concept of the Challenge Lab (C-Lab), in which the work was executed.

1.1 The Challenge Lab

Founded in 2014, the Challenge Lab (C-Lab) is a platform that accommodates Chalmers University of Technology master's students from diverse educational backgrounds working in the field of sustainability transitions. These transitions are of a transformative and integrative nature. Transformative by challenging the status-quo and integrative by connecting actors from the triple-helix of academy, public- and private sector. It has been formed as an initiative of the so called Areas of Advance (AoA) of Chalmers. The interdisciplinary approach of these Areas of advance is mirrored by the composition of students in the C-Lab.

The C-Lab's goal, as stated by Holmberg (2014), is to create a natural hub within the five regional knowledge clusters in the region West Sweden (Urban Future, Marine Environment and Maritime Sector, Green Chemistry and Bio-based Products, Sustainable Mobility, and Life Science). Within this hub actors from the triple helix of society, business, and academy are interconnected by the students who act in a simultaneously non-threatening and challenging way, resulting in a trust-building surrounding. The students on the other hand get the opportunity to develop a set of skills in an interdisciplinary working environment. They are dealing with the sustainability challenges of today positioning them to become "powerful change agents" (ibid, p.97). The major methodologies and tools used in the C-Lab are backcasting, self-leadership, and dialogues. They are further explained in chapter 3, theory.

To engage with regional stakeholders and shift the status-quo towards a desired state, the students take the role of a "change agent". This allows them to obtain more transparent responses than a person from another institution could get (Holmberg 2014). The aim is that the students, themselves are challenging relevant stakeholders and connecting them within an open and trustful platform, eventually triggering a transformation.

In 2017, 16 students who possess a wide spectrum of personal and educational backgrounds (11 unique master's programmes) came together to share their interdisciplinary knowledge in order to identify and tackle regional sustainability challenges.

During the course of C-Lab, all Master's theses follow two phases. Phase One focuses on the process of finding a relevant research question to be dealt with in Phase Two. This is done by learning about regional sustainability challenges, executing stakeholder dialogues, identifying one's personal values in a self-leadership training etc. During this process, the students identify the topics they want to work on and eventually formulate research questions. The investigation of this research question is undergone during Phase Two. Whilst Phase One is undergone by all 16 students jointly, Phase Two is carried out in pairs who work on their respective topic.

1.2 Background

Although disregarded by some political groups worldwide, climate change is one of the most crucial challenges that humankind is facing. The main cause of this challenge is the gradual increase of Greenhouse Gases (GHG) such as CO_2 , CH_4 and N_2O concentrations in the atmosphere. The consequences of climate change and global warming are observed on various locations on the planet, even influencing the migration patterns of different species due to sea-level rise, coastal flooding and droughts (Raleigh & Salehyan 2008). Climate change mitigation is prioritised on the agenda of supranational organisations such as the United Nations (UN), European Union (EU) and many others. Recently stated by Harvey (2016), if not taken seriously, this might trigger the event of a "climate tipping point", resulting in the white ice caps in the Arctic to be replaced by vegetation of tundra. This will lead to more light and heat absorbance by the earth and emission of more methane from tundras causing an

irreversible alteration in the ecosystem. The GHG mentioned above are mainly emitted from anthropogenic sources such as industrial activity, food production and fossil-fuel based transportation.

The EU has published a roadmap to provide guidance for member states in terms of energy production. They have set the goals of GHG reduction to 80% below 1990-levels by the year 2050. By the year 2030 the reduction should reach 40% and 60% by 2040. To reach the target values and slow down the global warming, energy production should be shifted to renewable alternatives and the production efficiency needs to be raised (European Commission 2017).

The EU has launched another roadmap to support their goals of GHG reduction, specifically to the transport sector. According to the White Paper, the design of infrastructure should clear the way for walking and cycling, making these transport modes an essential part of urban mobility (European Commission 2011). In the whole paper it is stated, this will not only reduce the overall emissions, but also will have a positive impact on congestion, the urban landscape and even improve the health of residents due to increased physical activity.

A new advanced technical solution is not always necessarily the best way forward in order to tackle pressing issues. Getting inspiration from how things were done in the past can help in finding a solution for present challenges. Being invented in the 1820s and having undergone various design stages until today, the bicycle can be one of those sources of inspiration. It has a range of advantages in relation to other mobility solutions such as flexibility, being free of emissions, low space demand or low infrastructure costs and has a positive impact on the health of the rider (Heinen 2011).

To tackle this issue, actors from all levels of society have to co-operate e.g. local authorities, civil society, businesses, students. Examples of these processes can be found in different cities, such as Copenhagen, Vancouver, or Amsterdam. This thesis describes a co-creational attempt to reach a similar result in the Swedish city of Gothenburg.

1.3 Research purpose and scope

The purpose of this study is to provide guidelines for scaling up the modal share of bicycles in the Gothenburg area. Providing background information about the advantages of bicycles as an urban mobility solution gives motives for supporting this mode of transportation. The research project focuses on a participatory and co-creational approach including stakeholders such as end users, researchers and consultants, as well as businesses and public planning authorities. It evaluates the data obtained from various sources and identifies barriers and drivers for such a transition using a multilevel design model. Based on the backcasting methodology, the thesis concludes with a recommendation for a road-map to support the goal of tripling the amount of trips that are done by bike in the city by 2025. The purpose is supported by asking the following research questions:

- *In which cases does cycling pose an advantage for the users over other modes of transportation?*
- *What are the potential barriers and drivers for scaling up cycling?*
 - *Where are they located in the multilevel design model and how do they influence each other?*
- *Which initiatives need to be taken in order to support the intention of up-scaling cycling?*

The above mentioned questions are answered by following four steps. Firstly, the criteria for sustainable urban mobility are defined and biking as a solution is evaluated accordingly. Secondly, the potential of the bike replacing other modes of mobility is identified using travel statistics. Thirdly, drivers and barriers for a transition towards a cycle-friendly city are analysed based on literature as well as end user and expert interviews. Lastly, a road-map with concrete actions is developed using the collaborative setting of an expert workshop.

1.4 Delimitations

This study is limited to the local barriers and drivers in the city of Gothenburg and its surrounding suburbs only. The maximum commute distance for cyclists is assumed to be 10 kilometres one-way. Moreover, it encompasses only currently available technology (conventional bike, electric bike, cargo-bike) and ownership regimes (individual private ownership, shared solutions, commercial use), therefore no new technical or ownership solutions are proposed. Best-practice examples from other cities are taken into consideration. However, quantitative benchmarking from other cities is not included in the scope of this thesis.

The information-gathering and solution-development is based on a co-creational setting including stakeholders from different fields but limited to the Västra Götalandsregionen (VGR).

1.5 Thesis outline

The thesis is divided into two major parts representing the two phases in which the research was conducted. Each part ends with the respective findings and a discussion of these.

Phase One focuses on the process of identifying sustainability challenges in the region of West Sweden. It gives an overview of the theory and method used and concludes with the corresponding results and a discussion providing the research topic that was assessed during Phase Two.

Phase Two describes the in-depth research being undertaken during the second phase. It focuses on the theory and method used and provides the specific results for this phase. At the end of Phase Two, **Chapter 11** elaborates on the results obtained. It does so by discussing the findings and concluding with areas to focus and a road-map proposal. The thesis ends with recommendations for further studies.



PHASE ONE

2. BACKGROUND

The following chapters introduce the background and situational context of the C-Lab providing a basis for understanding how it functions as an arena for student-supported sustainability transitions.

2.1 The knowledge triangle and triple helix

With the development of Chalmers' vision "Chalmers - for a sustainable future" the university has focused on increasing collaboration not only within the organisation but also with external stakeholders. The so-called Areas of Advance were formed by establishing 8 thematic fields (Building Futures, Energy, Information and Communication technology, Life Science Engineering, Materials Science, Nanoscience and Nanotechnology, Production, and Transport). These areas create a matrix organisation in the university by permeating the different departments. The Areas of Advance aim at enabling a better collaboration on an interdisciplinary level and to improve the integration between "*the three drivers of a knowledge based society - the three corners of the knowledge triangle: education, research and innovation*" (Holmberg 2014, p.95). In 2007 Chalmers appointed three new vice presidents in order to strengthen the collaboration inside the university between the corners of the knowledge triangle as well as with external stakeholders (ibid).

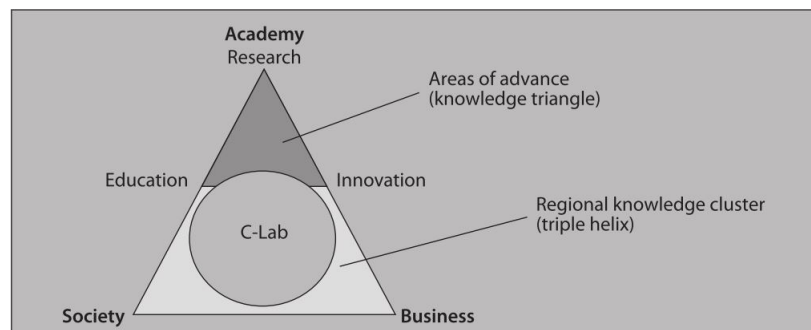


Figure 2.1 : Challenge Lab in the centre of the regional knowledge cluster (Holmberg 2014).

The Areas of Advance also facilitate the collaboration with external stakeholders within the regional knowledge cluster of VGR. The cluster consists of academy, society and business forming the so-called triple-helix as shown in figure 2.1. The C-Lab acts as a "bonding agent" within the knowledge triangle as well as the triple-helix by initiating student-supported transitions incorporating all of the aforementioned stakeholders (Holmberg 2014).

2.2 The student as a change agent

Many organisations tend to focus on their economic needs and performance only. As Flood (1998) points out in his review of the book "Fifth discipline" (Senge et al. 2015), an organisation needs to consider the wholeness of its operations. It needs to understand that its operations include ecological and social aspects as well. In order not to be locked into continuing "business as usual", external stakeholders can assist in freeing the organisation from a fixed mindset. When trying to undergo a sustainability transition, this is not a task that can be done by one person alone. Building a co-creational setting where people from inside and outside of the organisation cooperates can create an environment that encourages change. This way the process is undertaken by everyone involved rather than trying to force an idea on people that they do not believe in (Senge et al. 2015). Another benefit of external cooperations is that it creates a common ground for sharing knowledge. Opening a dialogue between each other enables every stakeholder to undergo a learning process which leads to finding new and better solutions (Flood 1998).

Undergoing a transition inevitably leads to entering unknown areas. Uncertainties within these areas include risks. In order to improve participation in this process the stakeholders need to operate in a setting that allows for certain risks to be taken. Trust is a key aspect in this relation providing an open setting for innovation and allowing mistakes to be made (Holmberg 2014). A high level of trust leads to a stronger cooperation within the group (Dirks 1999). Instead of concentrating on individual performance the group focuses on jointly creating an outcome. By building trust within the group and with external stakeholders a reinforcing cycle of trust, engagement, and performance can be established. This can help everyone involved in the change process to understand the 'why' – the reason for undergoing this process in the first place.

The students can function as a mediator and stimulate the change process. By acting within the platform of the C-Lab they create a setting which enables the involved stakeholders to open-up to new ideas. Because of the neutrality of the students, stakeholders have the possibility to think outside of their established structures without being afraid of making mistakes. In this way the stakeholders do not only offer their expertise to the C-Lab. They are also challenged by the knowledge and perspectives of the students and therefore gain new insights (Holmberg 2014).





3. THEORY

This chapter provides the theoretical background of sustainability, backcasting, self-leadership and the methodological description of using dialogues. It sets the scientific context for the reader to understand how Phase One has been executed.

3.1 Sustainability

Since the publication of *Our common future* in 1987, science has focused on the impact man has on the earth and its implications. As stated in the Brundtland report, sustainable development means meeting the needs of today without compromising the needs of future generations (World Commission on Environment and Development 1987). However, even 30 years after the report this does not seem to be the case. Several indicators can be found showing that the impact on the world as of this day is not sustainable. One renowned example for these indicators are the planetary boundaries as explained by Rockström et al. (2009). Many of the problems we face today have risen because most of the goods around are treated in a system of “make, use, dispose” (Stahel 2016, p.1). These linear processes end up in systematic extractions during the production and accumulations of substances following disposal. Holmberg et al. (1996, p.44) have proposed four principles for a sustainable society:

1. *Substances extracted from the lithosphere must not systematically accumulate in the ecosphere.*
2. *Society-produced substances must not systematically accumulate in the ecosphere.*
3. *The physical conditions for production and diversity within the ecosphere must not systematically be deteriorated.*
4. *The use of resources must be effective and just with respect to meeting human needs.*

While Rockström focuses on the environmental impact only, sustainable development means taking all three aspects - economical, ecological, and social – into consideration. Well-being as a fourth dimension of sustainability can be described as a personal dimension. Within the boundaries of nature, the social and economical development

should lead to fulfilling basic human needs and providing opportunities for personal advancement, therefore creating well-being in the present as well as in the future (Holmberg 2015). These four dimensions of sustainability are depicted in figure 3.1.

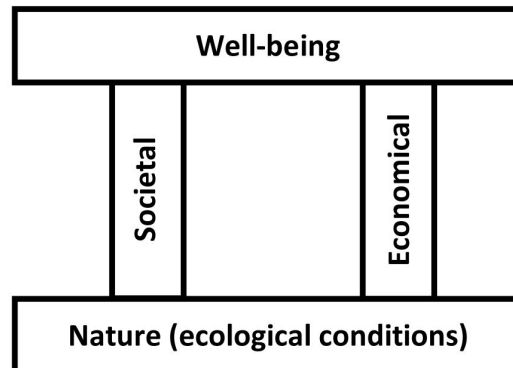


Figure 3.1 : The four sustainability dimensions (Holmberg 2015).

The concept of sustainable development remains rather vague to a majority of people. This is reflected by the UN regularly trying to establish and update definitions and guidelines on the topic. The evolution of the development guidelines began in 1959 with the proclamation of the 1960s being "The Development Decade", followed by "The Second Development Decade" in the 1970s. In 2000 the "Millenium Development Goals" focused on fighting poverty. They were replaced in 2015 by the Sustainable Development Goals (SDG). The SDG define 17 goals with specific targets to be reached by 2030 (Madeley 2015). They reflect all aforementioned sustainability dimensions and provide a good starting point for comprehension of sustainability as a concept.



Figure 3.2 : The seventeen sustainable development goals (United Nations Sustainable Development 2016).

Sustainability transitions require a collective approach to thinking and leadership (Scharmer 2013). It is very beneficial if there is no distinction between “us and them”, leading either to a blame-game or the feeling of not being responsible for developments within society, environment, and economy. In order to contribute to sustainability, organisations of any kind need to regard their operations as part of a system. Applying systems thinking will assist in order to develop an understanding for its commitment to the health of the whole (Senge et al. 2015).

3.2 Backcasting

Although the urgency for a change towards sustainability is being recognised, the approach towards solving this issue regularly focuses on improving the current operations only. This approach can lead to being locked-in and not coming up with true game-changing innovations. Senter (2014) quotes an anonymous person:

“The light bulb wasn’t invented by continuously improving the candle... it was about understanding what the job to be done was and then stepping back to look for solutions to solve this.”

Although possibly being a little over-simplistic, this quote describes very well how stepping away from present solutions can help in finding completely new ways of solving the problem. When analysing future scenarios Vergragt & Quist (2011) describe three different methods of envisioning the future:

1. Extrapolate (What *will* happen if the current trends continue)
2. Future studies (What *could* happen)
3. Normative scenarios (What *should* happen)

The first method is a simple forecast of how the operations will develop in the future. The second one takes several variables which could influence the development into consideration. Subsequently, several scenarios are imagined based on these variables developing into different extremes. Both are of rather reactionary nature. The third method is more relevant for transformative sustainability transitions. The backcasting method as described by Holmberg & Robert (2000) is one way of creating a normative scenario. It turns the concept of forecasting around by - instead of commencing with

the present situation - starting with defining an ideal future state and then developing a strategy towards that state.

As shown in figure 3.3, the backcasting methodology consist of four steps. In the first step criteria for a sustainable future are defined. These serve as a framework in which future solutions should be situated. Step two consist of analysing the present situation and comparing it to the criteria defined in step one. By doing so, gaps are identified between the present and a desired future. These gaps provide focus areas to work on when envisaging future solutions in step three. Step four consists of defining an strategy towards the desired future presenting a roadmap for the implementation of the transition (Holmberg 1998).

The backcasting approach used when executing this thesis was the second order backcasting as described by Robinson et al. (2011). In this approach the sustainability criteria are defined by the participants of the backcasting process. In this case they were defined by the students participating in the C-Lab. By using this approach the students were able to express their own vision of a sustainable future and learn about the consequences of these (ibid).

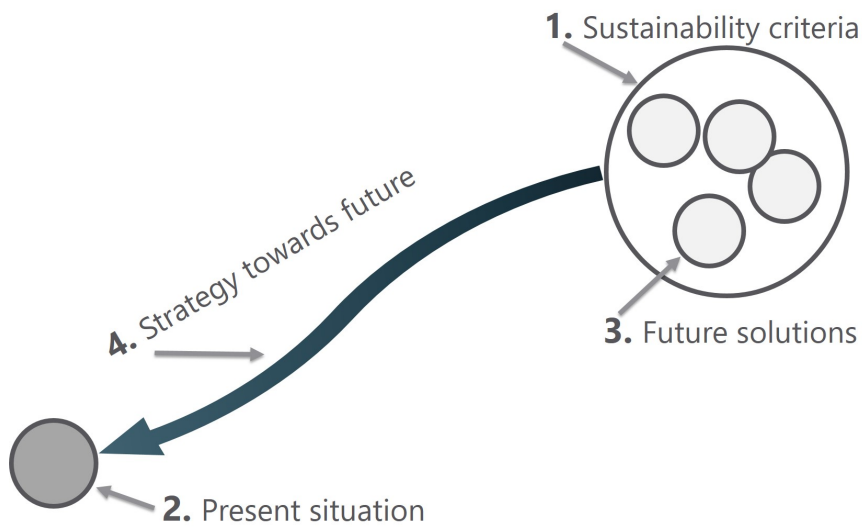


Figure 3.3 : The backcasting method (adapted from Holmberg (1998))

3.3 Self-leadership

Leading a transition in a complex field such as sustainability needs a strong personal vision behind it as a driving force (Holmberg 2014). The level of complexity requires a leader to develop a continuous learning process as there will always be new discoveries.

Learning new ideas also includes unlearning old ones. It means that you need to be able to let go of conceived ideas and concepts in the search for better alternatives (Senge et al. 2015). Intentional unlearning of knowledge can be helpful as sometimes existing knowledge can hinder a change process (de Holan 2004). Unlearning can be of a rather disruptive and difficult nature (ibid). A leader that wants to push such a process needs to commit themselves to that notion, therefore being able to free themselves as well as the group that is led from established ideas that do not support the transition. Strong intrinsic motivation has proven effective to increase the productivity of the individual (Stewart et al. 2011). This further supports the transition process.

Sustainability transitions mean letting go of ideas and concepts and constantly being curious about alternative ways of doing things. It can even be taken further by asking if an alternative for doing things is really needed or if the doing itself ought to be critically questioned. This requires opening up to different thinking, different cultures, and different beliefs as well as evaluating the underlying necessity of all of these in general. A topic as complex as global sustainability requires a double- or even triple-loop learning process (Gupta 2016). Curiosity helps in enduring this process. A constant appetite for gaining new knowledge combined with the attitude of not taking anything for granted can assist in freeing yourself from any present system and therefore creating a true vision for a sustainable future.

The need for performing a sustainability transition is still not regarded as necessary by many people. Others see a necessity but are not able to - or willing to - step out of their comfort zone. A leader towards this transition therefore needs to motivate and inspire others to wilfully join this undertaking. The inspirational process should be executed with care, not forcing others into a direction they do not want to take themselves. System leaders are described as “over time, their profound commitment to the health of the whole radiates to nurture similar commitment in others” (Senge et al. 2015, p.28). Inspirational leadership can help to build trust and commitment towards a common goal and therefore “foster attitudes directed at the collective team entity” (Joshi et al. 2009, p.249).

An inspirational leader will not only try to create a common goal for his or her team as it stands for a certain point in time but will also continuously try to expand that group by “engaging people across boundaries” (Senge et al. 2015, p.32). Inspiring others is

not an easy process and can easily turn into other people being annoyed by someone trying to persuade them of something they do not believe in. It is therefore important for an inspirational leader to balance how much they advocate and how much they inquire (ibid). Most of all, they need to 'walk the talk' acting as a role model in order to genuinely transport their idea. A strong inner commitment combined with a sense of curiosity and a room for building trust therefore is inherent to get other people on board (ibid).

According to Bolden et al. (2011, pp.46-47), a charismatic leader is among others characterised by showing the following behaviours:

- *Articulating and striving to change the status quo,*
- *acting as a role model for the set of values and beliefs to be shared by the group,*
- *willingness to incur significant personal cost to achieve a goal,*
- *encouraging the development of followers so that they share the desire for change.*

The C-Lab process focuses on fostering such leadership qualities in the students to provide a strong basis for true transformations (Holmberg 2014). The students are therefore trained in self-leadership and dialogue techniques in order to strengthen the trust within the group of students and prepare them to become leaders in sustainability transitions (ibid).

3.4 Dialogues

In order to overcome complex transitions, the focus needs to shift from solving a problem towards an openness for new ideas and solutions (Senge et al. 2015). A so-called learning organisation needs not only to cooperate with stakeholders within but also - and even more importantly - outside of the organisation. This can create an openness to shared mental models, a common vision for a future, a team learning process as well as a sense for responsibility (Flood 1998). Collective capacity as well as creativity can be developed by this kind of collaboration (Scharmer 2013).

The dialogue is one way of thinking together. Its main concept is "an inquiry that surfaces ideas, perceptions, and understanding that people do not already have" (Isaacs 1999, p.2). Opposed to a discussion, in which participants focus on defending their

opinions, the aim of a dialogue is to *think together* (ibid). According to Isaacs (1999), conversations are run by four different kind of actions that are shown in figure 3.4 and explained in the following:

- **Move** - thoughts and directions are given
- **Follow** - the statements of others are clarified
- **Oppose** - given statements are objected or challenged
- **Bystand** - a perspective of what is going on is given

These four actions can be characterised by two different positions, which are to **advocate** your own position and to **inquire** your own as well as other views. A major aspect of the dialogue is to find a balance between these two.

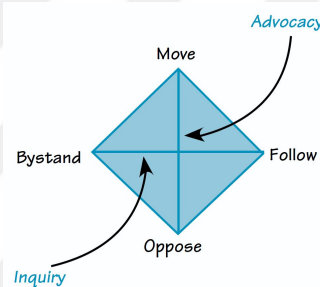


Figure 3.4 : Balancing a conversation (Isaacs 1999, p.3)

When leading a dialogue four different techniques can be used in order to enhance the quality of the outcome (Isaacs 1999). **Listening** goes further than having an own interpretation of the given statement. It requires the leader to "begin to participate fully in understanding how they understand" (ibid, p.4). **Respecting** other views is done by creating an atmosphere in which you "agree to disagree". It will provide others the safety to fully express their opinion although not necessarily agreeing to it. When bystanding with a strong awareness, the technique of **suspending** is used. This means that a thought or opinion can be expressed without the necessity to follow through on it. This opens the conversation for everyone to express their thoughts on a more objective level. Finally, **voicing** stands for taking the courage to express "what is true for each of us, regardless of all the other influences that might be brought to bear on us" (Isaacs 1999, p.5).

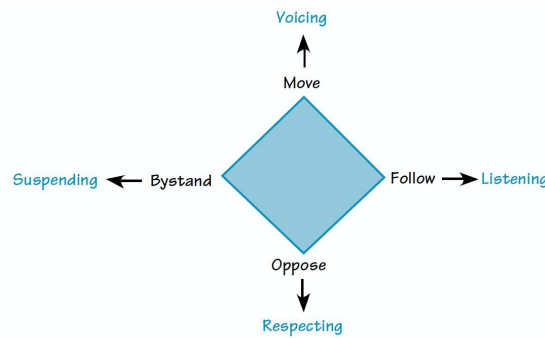


Figure 3.5 : Dialogic leadership (Isaacs 1999, p.4)

The dialogues, as carried out during Phase One, were mainly used for understanding the system and finding places where a leverage point (LP) can be identified. LPs are defined by Meadows (1999) as "*places within a complex system (a corporation, an economy, a living body, a city, an ecosystem) where a small shift in one thing can produce big changes in everything*". Meadows defines twelve places to intervene in a systems which are shown in figure 3.6.

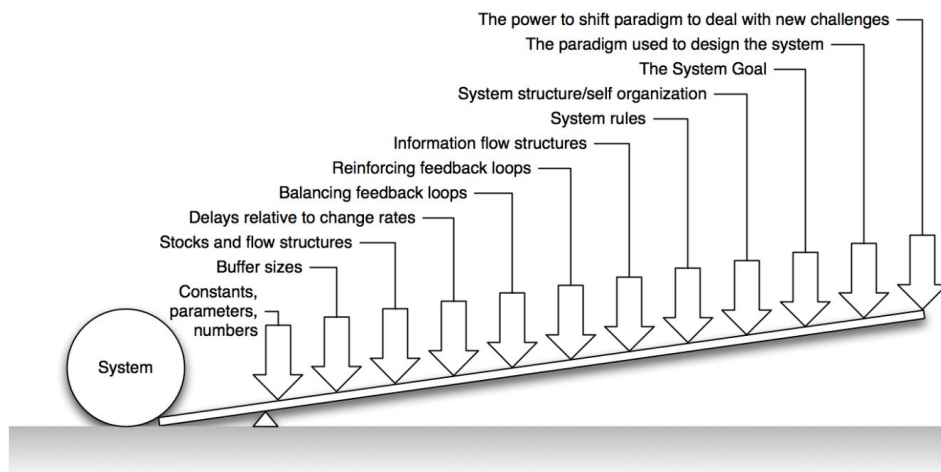


Figure 3.6 : The 12 leverage points by Meadows (1999) (Source: (Composite Creative 2014))

After identifying a LP, it is important to consider how it is used. If not considered accordingly, a LP can be pushed into the wrong direction creating undesired outcomes (Meadows 1999).

4. METHOD

In this section the methodology of Phase One is depicted by reporting on the workshops, group exercises and brainstorming sessions that were undertaken during the first four weeks of the C-Lab. Phase One consisted of several iterations of opening-up to new questions, topics, and ongoing activities and closing-down to concrete topics to focus on. The methodological approach of Phase One can be divided into two categories; outside-in and inside-out. Whilst outside-in focuses on getting to know existing tools, techniques, and knowledge about how to deal with sustainability transition, inside-out takes the inner belief systems, values, and personal strengths of the C-Lab into consideration. All of this was undergone with the whole group of 16 students until ultimately the thesis pairs with their respective research questions were formed. Starting with section 4.3.1, the undergone steps are described following the backcasting methodology as described in section 3.2 and referencing to the above mentioned categories.

4.1 Ethical Disclaimer

Prior to describing the methodologies applied during the course of this master's thesis, as stated by The Board of Chalmers University of Technology (2016), all research conducted at Chalmers University of Technology has to be based on:

- *Democracy and respect for everyone's equal value*
- *Human rights and freedom*
- *Quality, openness, participation, respect and diversity*
- *Firm scientific foundation*
- *Academic freedom and responsibility ensure integrity and objectivity*
- *Sustainable, long-term approach in our decisions and strategies*

- *Morally and intellectually independency of political, religious, ideological and economic power bases*

Furthermore, during the course of this thesis, we have decided to use pronoun "they", "their" and "them" in the single, gender-neutral form (English Oxford Living Dictionaries 2017). This further provides anonymity for the people interviewed and creates a more inclusive environment. The conjugation of the pronouns are made accordingly.

4.2 Systematic combining

Systematic combining as described by Dubois & Gadde (2002) is a research method in which an abductive logic is used. When using systematic combining, the researchers go back and forth between theories and their case study. The acquired insights from the case study are used to rephrase the research question as more knowledge is gathered. It describes a gradually evolving process as *"this stems from the fact that theory cannot be understood without empirical observation and vice versa"* (Dubois & Gadde 2002, p.555). Systematic combining consists of a continuous process of matching theory and findings, redirecting the research approach according to the gathered results. It can therefore be compared to a process of continuously confirming theory against generating theory. By redirecting the research question according to the findings of the case study, the gathered results are somehow case-sensitive and therefore cannot be fully generalised. This continuous learning process is revealed to the reader to provide a more transparent insight into the work undertaken (ibid).

4.3 Backcasting

In order to reach a relevant research question, we have been provided with several accessories, approaches and concepts. During Phase One, the backcasting process has been mainly applied to envision criteria for a sustainable future and match these against the present situation and ongoing developments. These first three steps of backcasting have been conducted via workshops, dialogue sessions, interviews, group projects, and background research. The third step was only lightly touched upon by identifying and

evaluating ongoing activities aiming for future solutions. By doing so, leverage points were identified that could be used for the execution of Phase Two.

4.3.1 Step One - Sustainability Criteria

To create a framework for sustainability transitions, criteria for an envisioned future (Stewart 1993) are required. These were decided upon in accordance with the four pillars of sustainability which were previously presented in figure 3.1 (p.12).

Criteria definition (Inside-Out)

First, each dimension (well-being, societal, economical and ecological) were assigned to groups of four students to be further broken down to linearly independent criteria. This process was carried out based on the *World Café* method (The World Café Community Foundation 2015). Each group had discussions with access to relevant literature (e.g. *the Hierarchy of Needs*, previously defined by Maslow (1943), for the well-being dimension). The contents of each dimension were defined accordingly. In the end, the hereby reached definitions were noted down to share with the rest of the students. They were further criticised and refined in the whole group to form the sustainability criteria for the future state. The output is presented in chapter 5, results.

Self-Leadership (Inside-Out)

During a self-leadership workshop, the students have selected their personal values divided into three groups (foundation, self-fulfilment, greater good). After sieving these down to 18 values, they exchanged in groups of three students by explaining the motivation for choosing the respective values and how they manifest them-self. In those settings one student acted as a listener who would not comment or question, one as time keeper, and one story-teller. This dialogue was conducted until everyone had played each role once.

Furthermore, each student wrote down a strength that they believe that they bear and how this could be perceived as a weakness if it was overused. This was done in order to find out their complementing strengths.

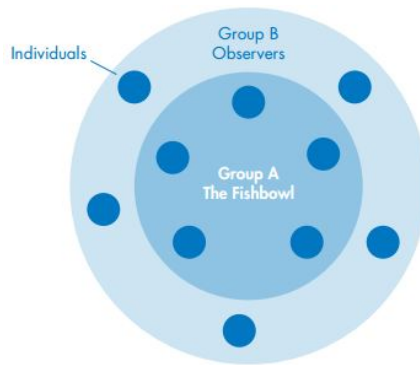


Figure 4.1 : Fishbowl setting (United Nations Human Rights Office of the High Commissioner 2011).

Finally, by assessing their own behaviour, they placed themselves on a triangular plane based on their values and tendencies. This was conducted to show them who might be their complementary partner within the group.

4.3.2 Step Two - Present Situation

In order to assess the present situation, stakeholders from the triple-helix (see section 2.1) were invited to three dialogue sessions. The dialogue sessions were organised according to the three main topics of this year's C-Lab: Circular Products, Urban Futures, and Urban Mobility.

Multi-Stakeholder Dialogue (Outside-In)

These dialogues took place on pre-scheduled dates and were moderated and documented by four (two for each role) students. The sessions were conducted in a *fishbowl* setting (United Nations Human Rights Office of the High Commissioner 2011) as shown above in figure 4.1. According to the setting, the main stakeholders who were coming from academia, public and private sectors, as well as from the civil society were placed in the inner circle along with the change agents who would actively participate in the dialogue. The outer circle participants would follow the dialogue and ask their questions after each session. Each dialogue was opened up with a check-in question, as an ice-breaker and concluded by asking them what they gained from the dialogue. During the intermission networking was encouraged between representatives and change agents. The outputs of each dialogue were discussed and the transformation needs in the region were mapped afterwards.

The circular products dialogue included stakeholder representatives mainly from the regional chemistry cluster and materials industries, as well as from academia. The urban futures dialogue included stakeholder representatives from academia, as well as housing companies, the local water management board and civil society organisations. The mobility dialogue included stakeholder representatives from academia, the local transport authority, civil society organisations as well as other transport researchers.

4.3.3 Step Three - Leverage Points for Future Solutions

During Phase One there were not yet identified or elaborated future solutions as this would be undergone in Phase Two. However, the third step of backcasting was executed by identifying ongoing processes and assessing LP's that could be used to support the activities that would be executed during Phase Two. Step three and four are further focused on during that phase.

Thematic Mapping and Leverage Point Assessment (Inside-Out)

Subsequent to the dialogues, the content of each dialogue was extracted to pave the road to the observed challenges in the region. Along with the students' personal motivation, these were mapped thematically with respect to the three focus areas. Furthermore, the stakeholders who could be interested in the planned research were identified and placed on the map where they would be suitable. Later, these challenges were further defined to obtain the *LPs*, based on the following three questions:

- What challenges does the LP address?
- How do we enter the LP?
- What can C-Lab do?

Next, the identified LPs were rearranged to find links between challenges. This led to forming more inclusive themes and finding synergies. The thematic mapping and LP assessment were iterated several times until all of the C-Lab students were divided into thesis pairs with a respective field to work on during Phase Two.

Expert interviews (Outside-In)

After the group formation, we have chosen the following topic to conduct research on: *"Integration of passenger, goods and waste mobility solutions in urban planning practices"*.

Following this decision, three expert interviews were conducted in an unstructured setting. Our aim was to reach key stakeholders who are involved in combined mobility solutions in proposed and existing development areas in the city of Gothenburg. We have contacted

- the planning office of a new urban development area,
- the management of existing combined logistics solutions,
- and finally, the transport authority of the city of Gothenburg.

The gathered insights of these interviews led to a reevaluation of the proposed research topic. This process is further explained in the results in section 5.3.

5. RESULTS PHASE ONE

In this chapter the outputs of Phase One are reported. It focuses on the definition of sustainability criteria (Backcasting - Step One), the assessment of the present situation (Backcasting - Step Two), and the selection of the topic to research during the execution of Phase Two based on ongoing developments (Backcasting - Step Three).

5.1 Sustainability Criteria

This section defines the C-Lab 2017 criteria for the four sustainability dimensions which were previously mentioned in section 3.1.

Well-being

- Everyone shall have the right to access their **physical needs** (subsistence, protection) such as health, security, food, water, sanitation, recreation, shelter and energy (Maslow 1943).
- Human life shall fulfill **psychological needs** such as affection, understanding, participation, idleness, creation, identity etc.
- Everyone shall have the equal opportunity and freedom to
 - choose and opt out,
 - express one's identity,
 - define and pursue their own goals, objectives and commitment.

Societal

A sustainable society is a system of individuals built upon the following:

- Empowerment
- Equity and Justice
- Trust between individuals and transparency
- A system to maintain well-being

- Openness to Development and Novelty

Economical

The economic system is an instrument that enables the other dimensions to be met efficiently and effectively in such a way that:

- Resources⁵ are used indefinitely and non-depleting.
- It shall ensure a fair distribution of resources⁵.
- It shall be resilient to disturbance and disruption; flexible enough to adapt to changing conditions.
- It shall facilitate transparency and trust.

Ecological

- Nature shall not be subjected to systematic increase of concentrations of substances⁶.
- Substances⁶ shall not be extracted in a way it disturbs the balance of natural cycles.
- Nature shall exist in harmony as one system, enabling ecosystem services and biodiversity.

5.2 Identified Challenges and Leverage Points

Many challenges and leverage points (LP's) were identified during Phase One. To report all of these in this section would go beyond the scope of this thesis. Therefore one representative example for a challenge is depicted in figure 5.1:

⁶Natural or man-made

⁶A specie of matter of definite chemical composition

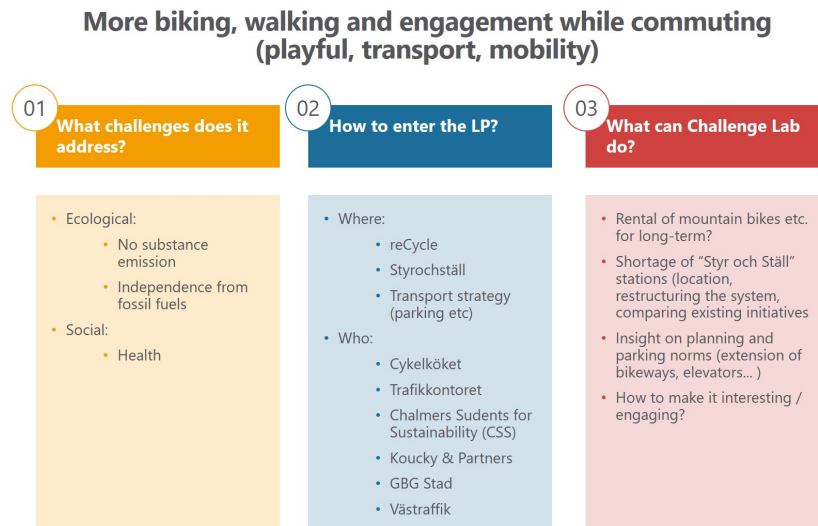


Figure 5.1 : Example of identified challenges

Prior to the group formation, the recognised LP's were as seen on table 5.1. Due to great interest in the mobility theme, the process of pairing up in this field has taken longer time than the other groups. This process is further described in the next section.

Table 5.1 : Thematic Mapping

Theme	Ongoing Processes & Leverage Points (as proposed by students)
Social	Urban regeneration (Place-making) Sharing movements Densification Meeting places
Recycling	E-Waste Content declaration for products Collection and distribution of material streams in industry Incentives to provide guarantee for the whole life of products Car tires
Mobility	Generic infrastructure for energy supply in electromobility Multi-modal transportation, passenger-cargo integration Building trust in the public transport, communication and transportation integration River integration Identification of barriers in the transportation system More biking, walking and engagement while commuting
Food production	Urban farming
Ecosystem services	Implementing ecosystem based solutions in dense urban areas River aquapark projects Urban beekeeping
Arena	Usability and accessibility of MaaS ⁴ Promoting bottom-up initiatives Interaction between people from all parts of the city Inclusion of citizens in the decision making process

5.3 Team formation and topic selection

During the above mentioned iterations on the challenges and LP's, the group of 16 students was progressively separated according to their fields of interest. By the end of Phase One, the mobility group that we are part of, consisted of 6 students. Several more iterations just within this group were undergone until we formed the final thesis pairs and corresponding research topics. The topic we have chosen was the "*integration of passenger, goods and waste mobility solutions in urban planning practices*". This was brought up by an attending stakeholder during one of the dialogue sessions. The topic was identified as a challenge resulting from planning for new urban areas in which

⁴Mobility as a Service

very little to no parking spaces are designated. As parking spaces are not only required for private automobiles but also for the delivery of goods and pick up of waste, the reduction of these poses the need for alternative logistics solutions. After choosing this topic, we conducted the first expert-interviews as mentioned in section 4.3.3. However, during the last mentioned interview, we have come to the fact that the topic requires far more expertise and experience than we were holding at that moment. Therefore we have reached the consensus to look for an alternative topic to study based on our common interests. However, we continued focusing on issues related to reducing the number of private cars in the city as already earlier in Phase One we have agreed upon that this form of mobility, even if cars in future are electric and self-driving, does not conform with the sustainability criteria that we defined in Step One. Therefore, we have decided on the broader topics of "Identification of barriers in the transportation system" and "More biking, walking and engagement while commuting" from the table 5.1. Finally, after having several group discussions and a meeting with the coordinator, we have finalised our topic as "Strategies to increase bicycle use as preferred mobility solution in Gothenburg". This topic fully complies with the aforementioned criteria for sustainability, as will be shown in Phase Two.

5.4 Cycling and four pillars of sustainability

"The ideal transport would be instantaneous, free, have an unlimited capacity and always available." (Merlin 1992).

While this may not be the case for most of modes of transportation (modes of transportation (MoT)), for cycling, we can surely argue that it might actually be the case. As opposed to other available modes, cycling

- reduces the pressure on the **environment** by eliminating tailpipe emissions and noise pollution;
- improves the **well-being** of individuals by increasing their physical activity;
- due to its simplicity provides a MoT that is **economically** viable and resilient to disturbances;
- empowers the population by providing **society** an affordable and healthy alternative for their mobility needs.

Therefore, cycling complies with all four pillars of sustainability.



6. DISCUSSION PHASE ONE

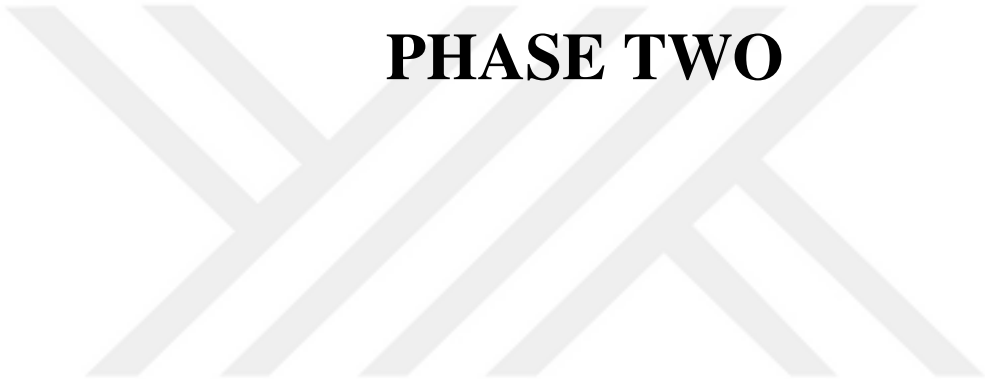
This chapter discusses the knowledge obtained from the execution of Phase One focusing on insights from the methods that were used. As mentioned above, the methodologies applied (especially the backcasting methodology, the training in self-leadership, and the dialogue sessions) encouraged in forming a strong and determined team willing to challenge themselves as well as existing unsustainable practices in the world. However, these methodologies also come with their downsides. The advantages and disadvantages of executing Phase One as done are therefore discussed in more detail in the following.

By applying the backcasting methodology and therefore starting with the definition of a sustainable future, you enable yourself to step out of present constraints to prepare for truly sustainable transitions. This is how we prepared for the thesis work in the beginning of Phase One. Although this process frees yourself from just slightly improving the current situation once more, it poses the threat of also letting go of good and sustainable solutions that are around as ideas already. By wiping the page blank, good as well as bad concepts might get lost in the process. This is what happened to some of the ideas that were already existing when starting the thesis process or which came up in the very beginning of it. However, in hindsight eight exceptional thesis works were carried out during this year's C-Lab and both authors of this thesis feel very confident with the work they achieved. As only a finite amount of challenges can be tackled and time is limited, a few "darlings have to be killed" to stay focused.

Additionally, the multidisciplinary setting of students in combination with the development of a strong value system leads to a good confidence in the group. Nonetheless, this confidence can lead to an overestimation of one's own abilities. This is what happened to us in the end of Phase One, when after a straining process of finding a research topic we were planning to tackle a case in which we were missing a lot of necessary background knowledge. In some cases some tasks need to be left to the experts in that field to be solved. In other cases however, especially a multidisciplinary

background can help in seeing the bigger picture. It is therefore required to regularly re-evaluate your own work and progress in order to not get lost along the way. Yet, this is what we did when questioning our first research topic and which lead to an even deeper commitment to the final topic chosen. Challenging the existing system therefore as well includes continuously challenging yourself. A careful balance of inquiry and advocacy is therefore not only necessary for a successful dialogue as already explained in section 3.4, but also when undergoing sustainability transitions.

As mentioned before, the execution of Phase One was accompanied by a vast gathering of new insights, but also with several instants that demonstrated one's own limitations. However, the hereby chosen research topic was therefore undergone with an even stronger motivation. The following part will explain in detail the undertaken research approaches and elaborate and conclude on the findings observed.



PHASE TWO



7. BACKGROUND

The research purpose is described in section 1.3, phase two starts with a geographical and demographic background as well as a description of some of the large-scale ongoing urban development projects in the area of Gothenburg and the local cycling strategy program.

7.1 Geographical background

The city of Gothenburg is physically divided in two major parts by the Göta river. They consist of the southern "mainland" and the northern island of Hisingen. Currently there are several crossing points that allow the cyclists to move from one side of the river to the other. There are the Angered, Göta river and Älvborg bridges, as well as ferry lines. The ferry line 286 is operated between Lindholmen and Stenpiren terminals, which provides the passengers and cyclists a free travel during the weekdays (Västtrafik 2017b). Moreover, the southern archipelago is only accessible by sea transportation. The ferries allow cyclists to reach both archipelagos; the southern archipelago is not accessible for car travels.

7.2 Demographic background

Located in the region of West Sweden, the City of Gothenburg is home to approximately 557 000 inhabitants. The Gothenburg+ region as defined by the local public transportation authority and shown on the figure 7.1, further includes the municipalities of Mölndal, Partille, Öckerö, and parts of Kungälv, Ale and Härryda. However, in our analysis the municipalities that appear on Gothenburg+ zone, Kungälv, Ale and Härryda are not included. Mölndal municipality is home to roughly 64 000 inhabitants, while Partille and Öckerö are 37 000 and 13 000, respectively. Together, the four municipalities are home to a combined population of 671 000 inhabitants by the 31st of December 2016 (Statistics Sweden 2017).

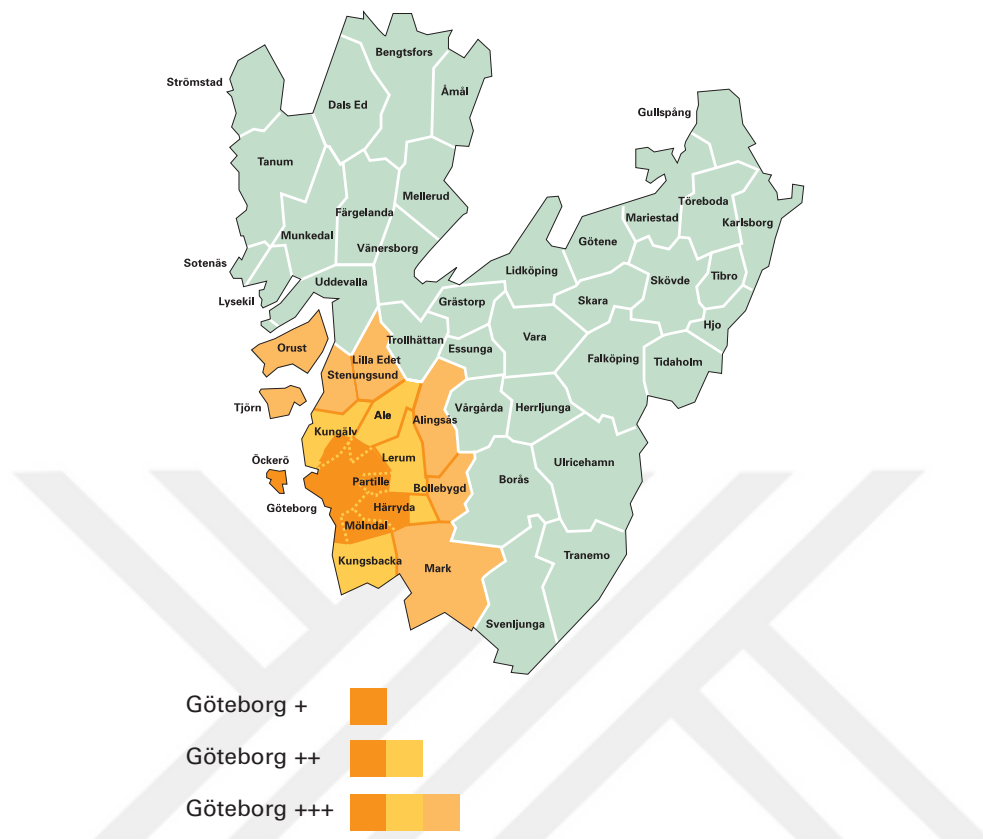


Figure 7.1 : Region West Sweden public transportation zone map
Västtrafik (2017a)

7.3 Ongoing urban development projects

In this section, major city-wide ongoing infrastructure and urban development projects are described.

7.3.1 West Swedish "Västsvenska" projects

"The West Swedish Agreement includes a host of improvements to public transport systems – railways, roads and cycle paths. Combining different modes of transport will be easier with improved traffic information and new parking facilities for cars and bicycles. As part of the improvements new footpaths and cycle paths have been built, roads have been widened and noise barriers have been created. The West

Swedish Agreement is improving travel within the region now and for many years to come."(Trafikverket 2017) [our translation].

As shown in the quote above, taken from project's website, the regional authorities state their commitment to the case of solving the mobility issues in the region by offering a selection of infrastructure solutions. The project is funded partly by the national government (mainly through a special congestion tax for cars) and partly by regional and local governments.

Some of the elements included in the project are:

- **West Link "Västlänken"** reduces the amount of overground train tracks by taking them underground and creating two new train stations in the city centre.
- **The new Göta river bridge "Hisingsbron"** replaces the current "Göta Älvsbron".
- **Gamlestaden Hub** creates another transfer hub between modes of transportation (MoT).

At the writing stage of the thesis the projects were already on the actualisation stage. This caused major construction activities and re-routing in the central Gothenburg area.

7.3.2 Rivercity "Älvstaden" project

The Rivercity urban development project covers the north and south banks of the Göta river. It will eventually make the city of Gothenburg more densely populated. The districts covered are listed on the project website as:

- Backaplan
- the area around the central station
- Frihamnen
- Gullbergsvass
- Lindholmen
- Ringön
- Södra älvstranden

(City of Gothenburg 2017)

Densification of the central city addresses the issue of increased need for mobility for the residents and commuters. Furthermore, when the project is finished, in one of the districts mentioned above, Frihamnen will have lower ratio of parking spaces available, to reduce the amount of privately owned cars.

7.4 "Cycling program for a closer metropolitan city 2015-2025"

Issued by the local traffic office, "Trafikkontoret", in March 2015 with the name of "Cykelprogram för en nära storstad", this strategy report paves the path for future development of a cycling friendly city. For the course of the thesis, this report is shortened as "cykelprogram" for convenience of the readers. Aligned with the previously published "Gothenburg 2035, Traffic strategy for a closer metropolitan city" report (City of Gothenburg 2014), "trafikstrategi" for short, and based on traffic survey 2011 results (Transport Analysis 2017), cykelprogram sets the goal of, *"tripling the total count of daily single cycling trips"* (City of Gothenburg 2015) [our translation] by the year of 2025. Due to an overall increase of traffic in the city, this would result in doubling the total share of cycling trips from 6% in year 2011 to 12% by 2025 City of Gothenburg (2015).

8. THEORY

This chapter provides the reader with a theoretical background about the urban environment and the various existing mobility solutions within. It furthermore summarises major research findings about cycling in the city. Lastly, the multilevel design model is explained. Together with the backcasting approach that is previously explained on Phase One, they form the two methodologies applied in this thesis.

8.1 Urban environment

In the course of this section, the challenges being faced in urban mobility, dependence of cycling on other factors in urban environments, as well as the impacts of cycling are presented.

8.1.1 Urban mobility

In this section issues related to different urban mobility modes are elaborated. While ongoing research focuses on reducing the tailpipe emissions by providing zero-emission alternatives to individuals, congestion in both public transportation (public transportation (PT)) and roads are other issues that leads to reducing the productivity, well-being of residents, as well as efficiency of other sustainable modes of transportation (MoT).

According to Rodrigue (2006) the urban mobility issues that need the most attention are:

- **Congestion** occurs when the growth of mobility are not met by growing transportation infrastructure, mainly linked to the usage of private cars.
- **Insufficiency of PT** occurs when the demand for mobility is not uniformly dispersed, meaning overcrowded vehicles during peak hours and economically unviable services that run in suburban zones.

- **Hindrance for pedestrians** emerges from poor consideration of pedestrians during the design stage of the infrastructure creating an impairment of pedestrians.
- **Inefficient energy use** that includes fossil fuel consumption, and **environmental impacts** such as air and noise pollution that impairs the well-being of urban populations.
- **Lack of safety** which would increase the number of fatal and non-fatal accidents resulting in urban populations to feel less reluctant to use the streets.
- **Land utilisation** of all mobility linked services are estimated to be between 30 - 60% of all urban area due to over-dependence of certain MoT.
- **Logistics** services mainly share the same infrastructure as passenger mobility services resulting in a shortage of both services.

In order to tackle these complex challenges, a holistic urban mobility management approach needs to be taken, including a combination of available technologies, rather than focusing on one niche.

One of the debates that this study investigates is, whether the local climate poses an impact on cycling in urban areas. According to Buehler & Pucher (2011), a study that samples commuting behaviours in 90 cities in the US, there is no significant connection between precipitation and commuting by bike. They have further investigated extremely cold (below 0C) and extremely hot (above 32C) days per year and their findings show no remarkable difference. Therefore, bike commuting is found to have no strong connection to climatic factors.

Another factor examined was the influence of cycling infrastructure on the share of bike commuting. Buehler & Pucher (2011) have indicated that the bike commuting is significantly influenced by provided cycling infrastructure, whether it is in the form of bike path, meaning there is no separation between the two active mobility (active mobility (AM)) modes (on foot and by bike); or bike lane, where there is a separation between the two. The studies further state that there were no remarkable differences between having provided bike lanes or bike paths: 10% of increase in supplied bike paths/lanes would result in 2.5% and 3.1% increase in bike commuters, respectively (Buehler & Pucher 2011).

Other factors not to be neglected are students' presence in urban areas, the size of urban communities, and fuel prices. Buehler & Pucher (2011) has stated that 10% of increase in share of students over the whole population would result in 8.6% greater share of commuting by bike. Moreover, people who prefer to cycle tend to live in smaller communities and less likely to own a personal car (Buehler & Pucher 2011). Furthermore, they have indicated the relation between fuel prices and the share of cycling: fuel price increase of 1% would result in 5.2% increase in the levels of cycling (Buehler & Pucher 2011).

Cities that undergo an urban renewal were another area that needed to be examined. Part of urban renewal is reconstruction of existing roads to increase the capacity and to serve a larger population. However, this requires temporary shutdown of certain road sections and rerouting. In Antwerp, Belgium during the reconstruction period that will take several years, the traffic approaching inner city has been greatly reduced and diverted to stay in the ring road (GopressMobility 2017a). Therefore, the mobility managers had to seek other sustainable solutions to keep the citizens' mobility demands met via offering public transportation (PT), foldable bikes or electric bikes (e-bike) (Adams 2017). Moreover, it was reported that the sales of foldable bikes have climbed up by 12 to 50% and e-bikes have skyrocketed by 130% compared to the figures of previous year (GopressMobility 2017b).

8.1.2 Impacts of cycling in urban environment

The impacts of cycling in urban environments (also known as urban cycling) can be measured with environmental and social indicators. This is carried out by either personal ownership of the technical solutions previously mentioned or via bikesharing. Bikesharing projects provide the extent of improvement achieved by supplying such a service to the public, while holding the advantage of being easily traceable. According to Shaheen et al. (2010), these projects can be categorised under:

1. Advertising companies that receive the right to advertise in urban areas, in exchange for providing bikesharing.
2. Public transportation (PT) agencies that provide bikesharing to complement the mobility services they provide.

3. Local governments that provide a bikesharing service either by purchasing from other providers or sketch and operate them directly.
4. For-profit providers that operate profitable services with minimal subsidies.
5. Nonprofit providers that operate services with some subsidies from public sector.

Currently there are two operators offering services in Gothenburg, "Styr och Ställ" and "Donkey Republic". The first one falls into category one while the second falls into category four out of the classes that were mentioned above.

As indicated by Shaheen et al. (2010), a bikesharing system that operates in France, "Vélib", covers an estimated sum of 312,000km per day, reducing the total amount of CO_2 emitted by about 60,000kg. They have further reported that 89% of the users of Vélib pointed out that their mobility has improved, while another system, "SmartBike" has made it more convenient to travel in Washington, D.C., according to 79% of their users (Shaheen et al. 2010).

The health impacts of cycling is another topic that needs to be assessed. According to the City of Copenhagen (2011) each kilometer cycled by an individual generates a health benefit of 51 eurocents to themselves, and 23 eurocents to the society, while the costs due to cycling related accidents are 3 eurocents and 7 eurocents respectively. This results in a net gain of 48 eurocents for individuals and 16 eurocents for the society. They report that the societal benefits are generated due to medical treatment expenses that were reduced and increase of tax income because of increased productivity. Costs, however, are dependent on the risks of cycling related injuries and medical treatment costs.

The empowerment of citizens via providing better cycling conditions is another aspect that needs to be noted. As stated in the newspaper The Guardian (2013), in Bogota -the capital of the world's eighth most unequal country, Colombia- cycling is perceived as a leveller between citizens with a quote from Ospina, who runs a social enterprise that promotes cycling based in the city: *"If people are on bicycles, they are equal, far more so than when they are in cars that could cost more than those on low wages could make in a lifetime."* Furthermore, it was indicated that using faces of public figures such as football players, politicians, models and actors while they cycle, makes it more attractive and fuels up the sustainability transitions (The Guardian 2013).

8.2 Multilevel Design Model

Truly transformative change processes involve a large amount of actors on all levels of society. These actors usually act in different regimes within one socio-technical system. Geels (2004) points out five different interlinked regimes to take into consideration when planning for innovation in such a socio-technical system. They can be summarised as (ibid):

- Technological and product regimes (technological innovations, requirements, standards...)
- Science regimes (research projects, conferences, publications...)
- Policy regimes (regulations, policies, administrative procedures...)
- Socio-cultural regimes (cultural norms and values, symbols, categories...)
- Users, markets, and distribution networks (relationships between users and companies, product quality laws, market demand...)

Urban mobility is one example of such an interlinked regime with an abundance of actors, activities, rules, institutions, etc. Planning for a transition in this field requires a thorough examination of the above mentioned regimes. In order to take all of the different actors and regimes into consideration and to be aware of possible interrelations and consequences on different levels, several design and innovation models provide a more structured approach to a prospective change agent. Design in this case does not only encompass product design but also urban development. According to Joore & Brezet (2015) a change agent needs a design model that:

1. *can provide insight into the development of new products and product-service systems, as well as in developments that occur in society as a whole;*
2. *can provide insight into the relationship between functional problems on the one hand, and more abstract societal problems on the other;*
3. *describe design processes, change processes and transition processes in a consistent, mutually comparable manner that can potentially be used to structure future design-based initiatives.*

The design model chosen for this research was the Multilevel Design Model (MDM) as described by Joore & Brezet (2015). It was specifically developed with the perspective

of the designer in mind (ibid). This model provides two separate functionalities. On the one hand a circular and iterative design approach and on the other hand a hierarchical systems approach. They are described in the following.

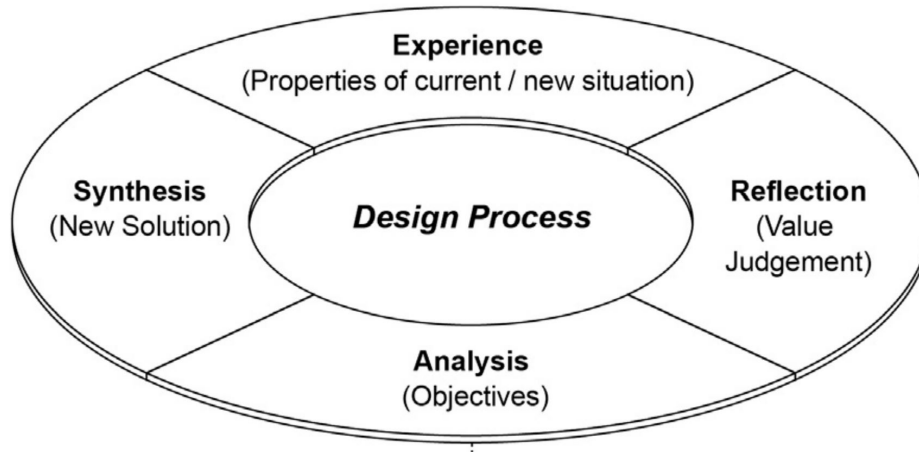


Figure 8.1 : Design cycle as applied in the multilevel design model (Joore & Brezet 2015, p.95)

As seen on the 8.1 The design approach describes four different phases of the design process. The phases are: (1) reflection, (2) analysis, (3) synthesis, (4) experience (Joore & Brezet 2015). After executing all of the phases they are iterated creating a circular process of improvement. Reflection focuses on the discovery of the present situation concentrating either on a problem or an opportunity. This is then followed by a deeper analysis of the problem or opportunity resulting in a first rough concept of a solution to it. During the third phase concrete ideas or solutions are synthesised. This phase is mostly referred to as the actual design phase, where detailed drawings, calculations, proposals or similar are developed. Lastly, these solutions are implemented and experienced creating a new present situation. The process is then iterated until a satisfactory results is generated.

The second functionality supplied by the MDM is the hierarchical systems approach. This provides a separation into four system levels. The levels as suggested by Joore & Brezet (2015) are the product-technology system, product-service system, socio-technical system, and societal system. On the basis of the MDM lies the product technology system. This system describes "*tangible, inextricably linked technical systems, physically present in place and time*" (Joore & Brezet 2015, p.96). The product-service system inherits the unity of physical and organisational components

that accomplish a specific function. If one of the components is missing, the function can no longer be accomplished. The socio-technical system is composed of a "*cluster of aligned elements, e.g. artefacts, knowledge, user practices and markets, regulation, cultural meaning, infrastructure, maintenance networks and supply networks*" (Geels 2005, p.445). These elements do not need to be formally related to each other and usually the system continues to function even if one or more of the contained elements stop working. System innovations take place on this level (Joore & Brezet 2015). At the top of the MDM lies the societal system. The Oxford dictionary describes this as "*the community of people living in a particular country or region and having shared customs, laws, and organizations*" (Stevenson & Oxford 2010). As this system is the most complex, it is no longer possible to summarise all of the components that make up this system. Changes in this system are usually described as a transition (Joore & Brezet 2015). To fully apply the MDM process, the aforementioned design cycle is executed in each of the four levels. An exemplary visualisation of the MDM process for a transition towards electric mobility is depicted in figure 8.2.

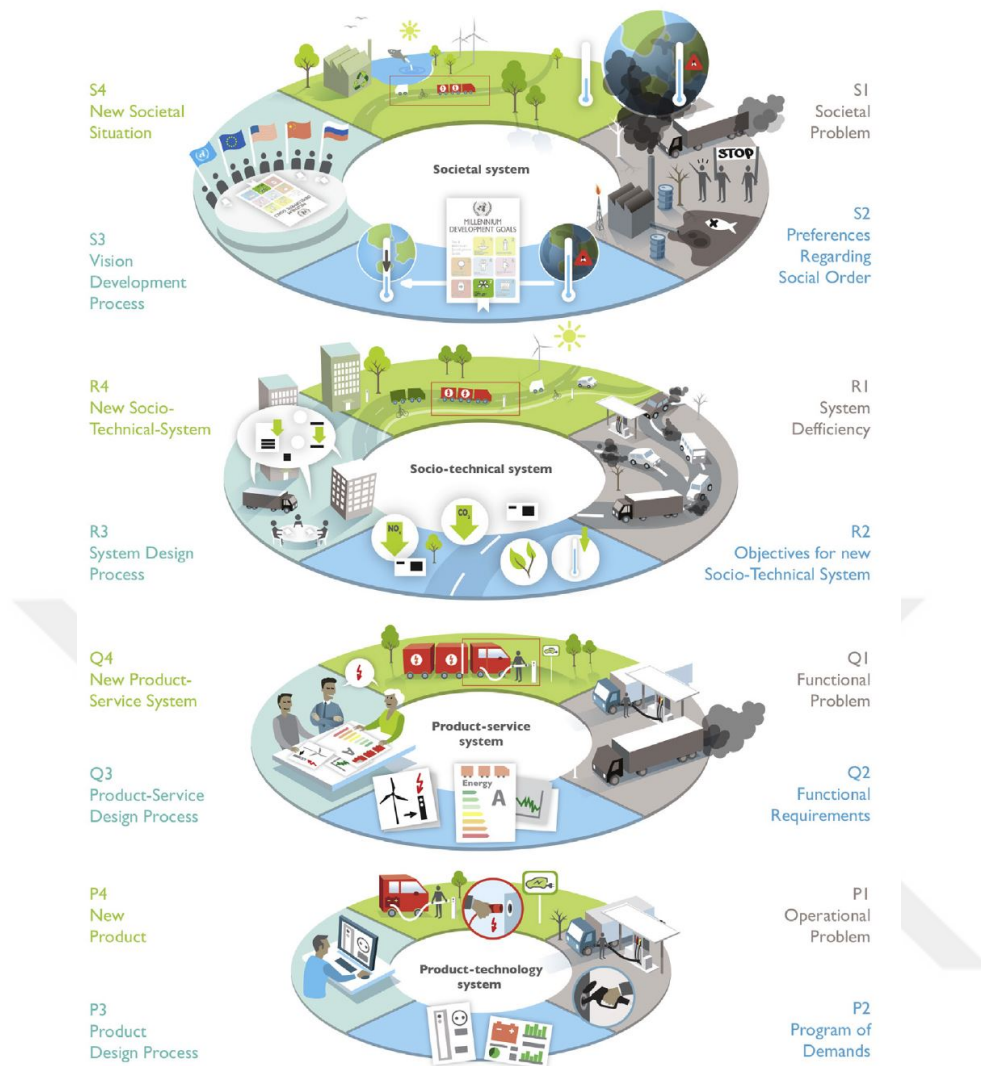


Figure 8.2 : Exemplary presentation of the MDM hierarchy (Joore & Brezet 2015, p.100)

9. METHOD AND DATA

The method section summarises the evaluation process of various sources such as statistical data, end user interviews, expert interviews, and a stakeholder workshop that we have organised during the thesis work.

9.1 "The Swedish national travel survey"

The main source of quantitative data obtained was the Swedish national travel survey, conducted by Transport Analysis (Trafikanalys: A Swedish government agency for transport policy analysis). According to their website, the survey was conducted by performing telephone interviews on a daily basis between 2011 and 2016. The respondents were of age 6 to 84 (Transport Analysis 2017). This travel behaviour inventory provides an important base for research and developments to serve people's mobility needs, including their behaviour in terms of communication as a substitute to travelling.

The survey is based on observations of 24 hours periods. Therefore, the majority of journeys are assumed to start from participants' home and end there as well. Thus, it is safely assumed that the distances obtained represent return journeys from and to their homes. However, several intermediate stops can be included in those return journeys. The survey results are used to analyse the current situation regarding cycling trips in comparison to other modes of transportation (MoT). The MoT's taken into account for the course of this thesis are:

- foot
- bike
- public transportation (PT)
- car and taxi
- other MoT

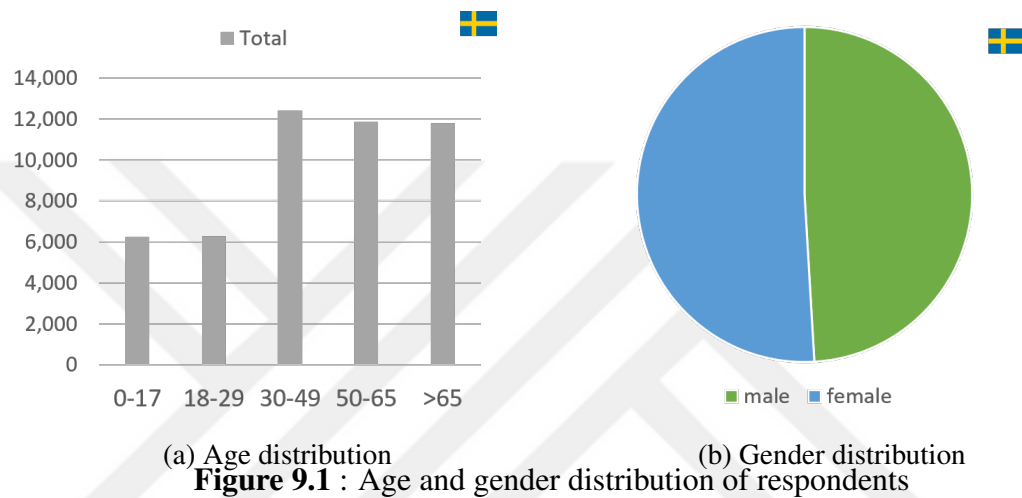
Foot and bike can as well be summarised as active mobility (AM); while PT includes buses, ferries, trams and trains. Mopeds, motorcycles, schoolbuses, and more unusual and unspecified MoT are summarised under "other MoT".

Subsequent to the identification of MoT for consideration, we have defined the parameters for evaluation of each mode. Firstly, the respective median velocities of each MoT were calculated to identify which MoT is superior in terms of speed. This was done by taking data from all over Sweden into account in order to provide a general description of the MoT, regardless of the region. However, it was limited to daily journeys up to a maximum of 100km. Secondly, the modal share of each MoT was assessed for distances travelled up to 100km (on a day) and 5km (for comparison). This was done for the region of Västra Götaland by counting the number of trips, but also by counting the total amount of km travelled to take the length of the trips into consideration as well.

Due to surprising results in the modal share, especially concerning the share of journeys on foot, we performed a more in-depth analysis of the multi-modal aspect of daily journeys. For that purpose the total km travelled on a day were not only divided by the respective single MoT, but also by the combination of MoT used on that day. This provides an overview of the so-called first/last-mile issue which describes that a lot of journeys (especially journeys by car or public transportation (PT)) require a small portion of the journey (eg. to and from the parking lot or PT station) to be taken on foot. To get further insights into that issue, the journeys made on foot were analysed by their distribution in combination with other MoT. As the results from this analysis showed that a large portion of journeys on PT or car are done in combination with journeys on foot, the initial comparison of speeds was repeated in a more detailed way, taking the first/last-mile issue into consideration as well and providing the overall median speed for door to door journeys.

Lastly, the development of the modal share of the different MoT over the maximum distance travelled on a day was analysed and visualised. This was done by visualising the modal share in overall percentage, but also by the sum of km travelled, providing a better overview of how many km were actually travelled respectively to the daily maximum distance. The data obtained assisted in finding different solutions based on how far people travel on a day.

The results from the aforementioned procedure are presented in the results in section 10.1 (from p.53). In total about 47,000 responses were collected in the survey. Out of these responses about 20,000 were given from people living in the region of Västra Götaland including around 11,000 responses from people living in the Gothenburg region. In the chapter 10, these are called Gothenburg. However, they include Öckerö, Partille, Härryda and Mölndal. Some background information about the respondents is given in the following graphs. This is provided as self-explanatory background information and therefore left uncommented.



9.2 End user interviews

The end user interviews were conducted in nine separate sessions in a semi-structured way, including 11 individuals. The end users included:

- One participant who used to cycle as main mode of transportation (MoT), however they are not cycling anymore, but willing to switch back.
- Three participants who have been cycling all their adulthood, who have never owned a car.
- Seven participants who currently practice active mobility (AM) as main mode of transport (MoT);
 - four of them own a personal car or member of a car sharing service,
 - three of them do not own a personal car.

All the participants are residents in the greater Gothenburg area, and currently working or studying at least two days of the week within the borders of the city of Gothenburg.

One of the interviews was a group interview of three participants, while the others were carried out as individual interviews. Both authors of the thesis were present at all nine sessions. The language of communication was English. Interviewees were briefly informed about the aim and scope of the master's thesis, how the interview is conducted and results are published. They all have given consent to keep the record of the interviews. During the course, one of us took notes of the ongoing interview, while the other was asking the semi-structured questions. We further promised to ask for their consent regarding their quotes, before this study gets shared with public and published. The interview themes are divided into background information, motivation, travel behaviour, and barriers and drivers

9.3 Expert interviews

The six expert interviews during Phase Two were conducted in an improvised, unstructured setting; as the experts were involved in different sectors. Our aim was to reach key stakeholders city-wide, however during the course of our progress, we have had the opportunity to also interview representatives from national and regional organisations, to identify the current situation and their plans. We have conducted interviews with representatives from

- the local traffic office "Trafikkontoret",
- one of the local parking solution providers,
- one bike-sharing solution provider,
- the national transport administration authority "Trafikverket",
- the regional planning office "VGR".

9.4 Stakeholder workshop

We held a stakeholder workshop at the C-Lab premises, to reach a co-creative output for future envisioned solutions. The participants of the workshop were involved in the triple helix structure and the civil society. The participants include:

- the local traffic office "Trafikkontoret"
- one of the local parking solution providers

- the regional planning office "VGR"
- the local non-profit bike kitchen "Cykelköket"
- the local cycling promotion association "Cykelframjandet"
- an international company that provides sustainable urban mobility solutions

We have participated as facilitators and two of our co-students have assisted in the documentation of the workshop. Prior to the workshop, the participants were informed about the rules as we set; that there are no recording or filming of the workshop, two colleagues are taking written notes whenever necessary, however if they have any off-record information that they would like to share, that part is not to be noted. Finally, the obtained results from the workshop shall stay anonymous.

Subsequently, we have presented our background, and results obtained, following with a brief discussion session. The co-creation part included a derivation of "brainwriting". The stakeholders were given five sheets of paper to express their ideas based on how they fit on the four layers of MDM, which was previously explained on the chapter 3, theory. Each turn of brainwriting was set to take five minutes. At the end of each turn they were told to pass the sheet to the next person, therefore completing their turn. At the end of five turns the sheets are returned to the first person to further summarise and present what they have gathered. The results obtained are shared in the chapter 10, results.



10. RESULTS

In this chapter, the results from Phase 2 are delivered. It provides the detailed results of the quantitative as well as qualitative aspects of the undertaken research, including travel statistics, end user and expert interviews, as well as the stakeholder workshop.

10.1 Travel statistics from Transport Analysis

The public authority Transport Analysis collected travel data of the whole of Sweden from the year 2011 to the year 2016. The travel statistics counted all of the different types of journeys undertaken on one day (Transport Analysis 2017). The data was analysed according to four major topics: a comparison of speed and distances, the modal share of the different modes of transportation (MoT), a deeper insight into multi-modal journeys and the first/last-mile solution, and a analysis of the modal share over the overall distance travelled on a day.

10.1.1 Comparison of speed

In order to analyse if the perception of cycling being inferior to other modes of transportation (MoT) in terms of speed is true, the speed of the respective modes was compared.

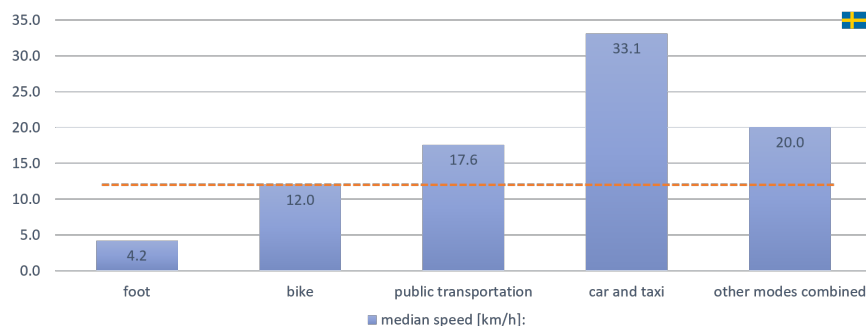


Figure 10.1 : Comparison of median speed depending on mode of transportation. Data taken from all over Sweden (for daily total distances of up to 100km).

As can be seen from figure 10.1, the median speed of cycling is inferior to most other MoT, especially journeys by car. However, the speed advantage of e.g. the car comes into play the most over long distances. The speed was further analysed depending on the distance travelled on one day. Figure 10.2 therefore shows the development of speed over distance travelled.

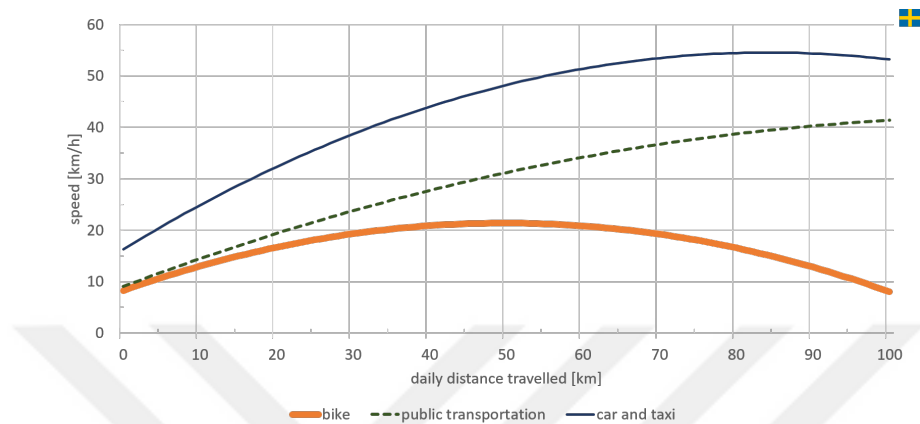


Figure 10.2 : Comparison of speed depending on the total distance travelled in a day. Data taken from all over Sweden.

Here, the car is still faster but the difference between cycling and using public transportation (PT) does not really come into play up until roughly 20km travelled. This comparison of speeds was done using data from all over Sweden to simply compare the MoT regardless of regional aspects. It was done for daily distances up to 100km (50km one way). To get a better picture of the regional context of Gothenburg, the median distance travelled per MoT was analysed for the Gothenburg region. In figure 10.3 one can notice that the median distance for the whole day and for those using public transportation was 16km. In figure 10.2 we saw that for total daily distances up to 30km the difference in speed using the bike or PT is very small. However, the the car is almost twice as fast as the bike for the distances that are common in Gothenburg.

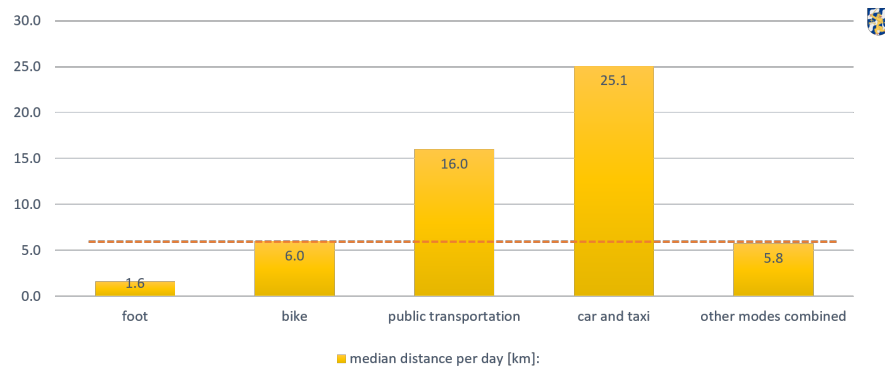
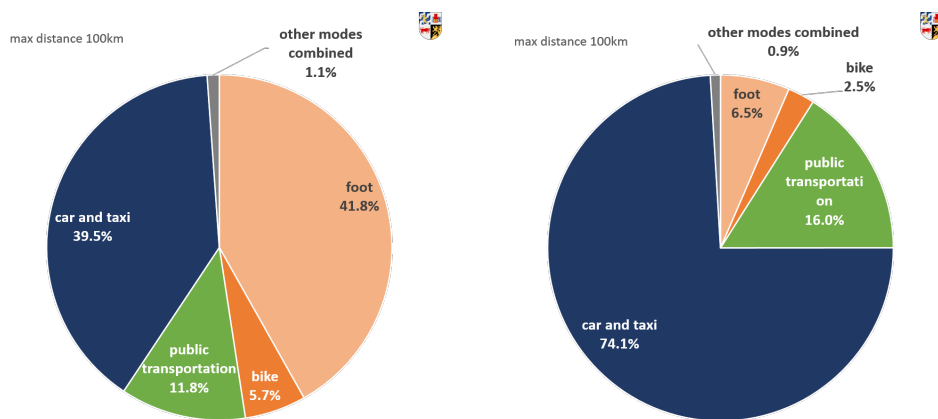


Figure 10.3 : Comparison of daily median distance travelled in Gothenburg (for daily total distances of up to 100km)

In this comparison, the speed was analysed concerning the use of the respective MoT alone. When taking the complete journey from door to door into account, many of the journeys on public transportation or on car and taxi include a small portion on foot (the so-called first/last-mile issue). The first/last-mile issue relativises the speed advantages of the single MoT. This issue is further looked into in section 10.1.3.

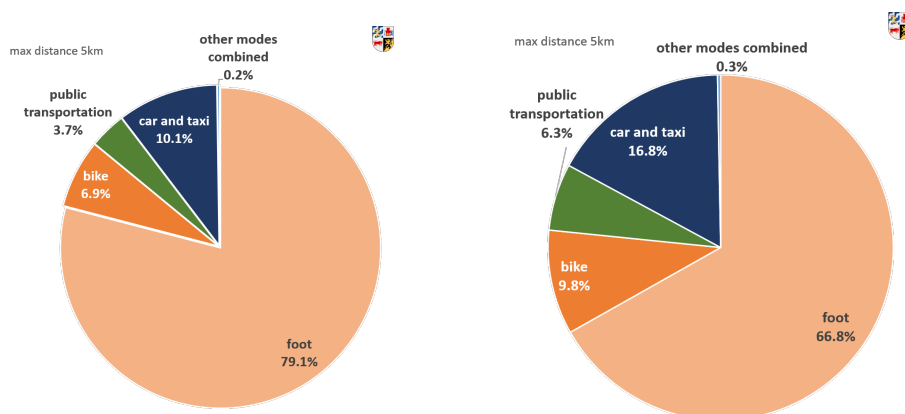
10.1.2 Modal shares depending on distance travelled

This thesis aims at providing guidelines for scaling up cycling in Gothenburg. Therefore, the present situation needs to be analysed in order to see where the share could be increased and from which modes of transportation (MoT) the share could be taken from. Figure 10.4 shows the modal share in the VGR in terms of (a) the number of journeys made regardless of the length of the trip and (b) km travelled in total per MoT. In this case VGR was chosen as the region to analyse due to a number of people commuting in and out of Gothenburg, which functions as a regional centre.



(a) Distribution of count of journeys (b) Distribution of km travelled
Figure 10.4 : Modal shares in Västra Götalandsregionen (only daily journeys up to 100km are considered)

Looking at figure 10.4 one can notice that the share of km travelled by car lies around 74% of all km travelled. When comparing this to the result that only about 40% of the journeys are taken by cars, the difference can be explained by the median distance travelled by car on one day which is a lot higher than the other MoT. When looking at the count of journey made by foot (42%), it seems to be a rather large number. However, the share in terms of km travelled is rather low which can be explained by looking at the low median distance travelled. Still, it poses the question why so many counts of journeys by foot appear. This phenomenon will further be looked into in the following paragraphs. In order to get more insights about the modal share depending on the maximum distance distance travelled, one more evaluation was made looking at a maximum distances of 5 km. The following graph shows the results for a maximum daily distance of 5 km travelled as a comparison to figure 10.4.



(a) Modal share of journeys (b) Modal share of km travelled
Figure 10.5 : Modal shares in Västra Götalandsregionen for daily journeys up to 5km

Looking at figure 10.5, the share of journeys on foot is clearly dominating in count and km travelled. This is not a surprising result taking the maximum distance travelled (5km) into account. However, it indicates possibilities of how to increase the share of cycling as well. As going on foot is dominant for these short distances, it does not make sense to focus on these types of distances in order to increase cycling if one does not want to take away this share from journeys on foot. This result stands in contrast to other statements saying that one needs to focus on small distances in order to increase cycling. This issue will be further elaborated on in the discussion chapter.

10.1.3 Multi-modal journeys

The high percentage of journeys on foot as seen in figures 10.4 and 10.5 was a somewhat surprising result. One possible explanation for this high percentage could be the first/last-mile issue which was explained in section 9.1. In order to understand if this could be the reason for the high percentage, the daily trips were analysed regarding on if they were done using just a single MoT or if they incorporated a combination of several modes. Figure 10.6 displays this analysis.

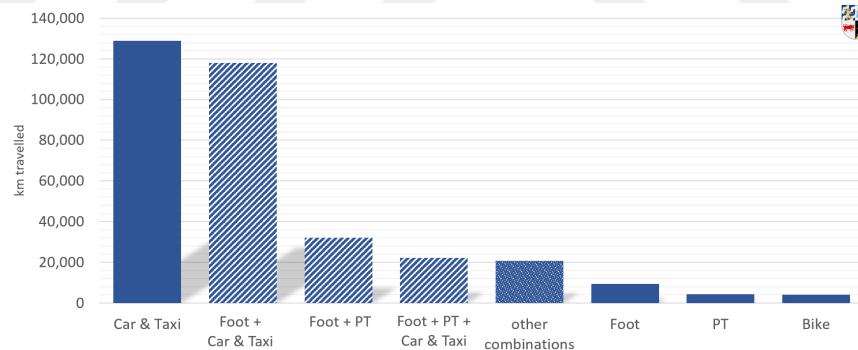


Figure 10.6 : Comparison of km travelled on a day in combination with other modes of transportation (for distances travelled up to 100km). Data taken from Västra Götalandsregionen

Around 40% of the journeys were done by car alone. However, the other 60% are dominated by multi-modal journeys, the largest part of them being car in combination with foot. These again indicate that a large portion of the journeys by car, but also by PT require a first-last mile solution on foot. This result is even more interesting when assuming that a large part of the first/last-mile journeys on foot were not reported. When looking at the raw data, out of the around 49,000 total respondents only 319 reported having travelled less than 200m by foot on a day. Many respondents have

probably not reported travelling by foot if it was relatively short. It can safely be assumed that the share of multi-modal journeys is even higher. In figure 10.7 the composition of three major multi-modal journeys are analysed. It is obvious that the portion on foot always represents just a fraction of the overall km travelled.

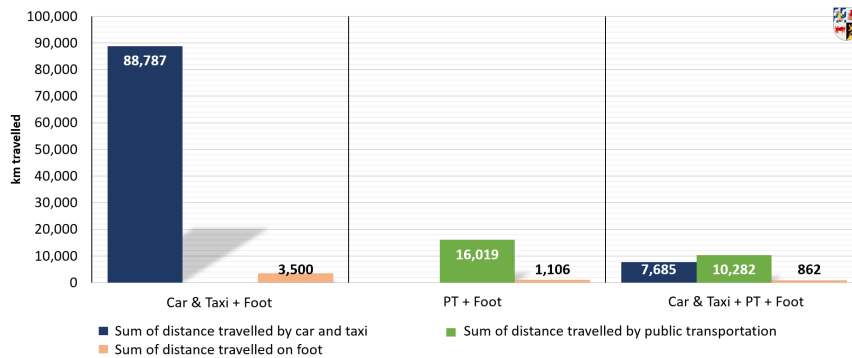


Figure 10.7 : Distribution over km travelled for combinations of different modes of transportation (for distances travelled up to 100km). Data taken from Västra Götalandsregionen

The hereby gained insights indicate that the majority of journeys taken by car or PT incorporate a first/last-mile solution on foot. Taking this and the fact that journeys on foot are relatively slow (see figure 10.1) into consideration, the speed advantage of cars and PT over cycling is relativised. In order to get a full understanding of the speed advantages, the comparison of speed as in figure 10.1 was repeated. Only this time the journeys on PT or car were split depending on if the respective MoT was used alone or in combination with a journey on foot.

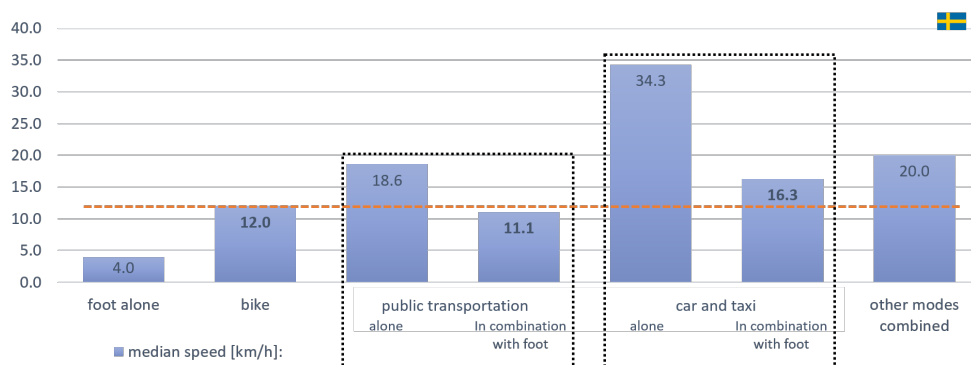


Figure 10.8 : Comparison of median speed depending on mode of transportation including multi-modal journeys for daily distances up to 100km. Data taken from all over Sweden

The results from figure 10.8 show that when taking the first/last-mile issue into consideration, cycling is around the same level as PT or the car. When taking the

results from figure 10.8 into context with the number of people using the respective MoT (see figure 10.6), the speed for using PT alone loses relevance as only very few people use PT without having to go on foot. The above shown figure also indicates one of cycling's main advantages which comes to play at multi-stop journeys. When needing to go to several places over the day, cycling is of great advantage to the other MoT as this form of mobility serves the complete journey without having to look for parking or the next PT station. As the majority of journeys made by bike are shorter than 20km (see section 10.1.4 and especially figure 10.10), we decided to repeat the comparison of speeds taking only daily journeys up to 20km into consideration. The results as shown in figure 10.9 indicate an even more significant speed advantage of the bike over the other MoT's for common cycling distances.

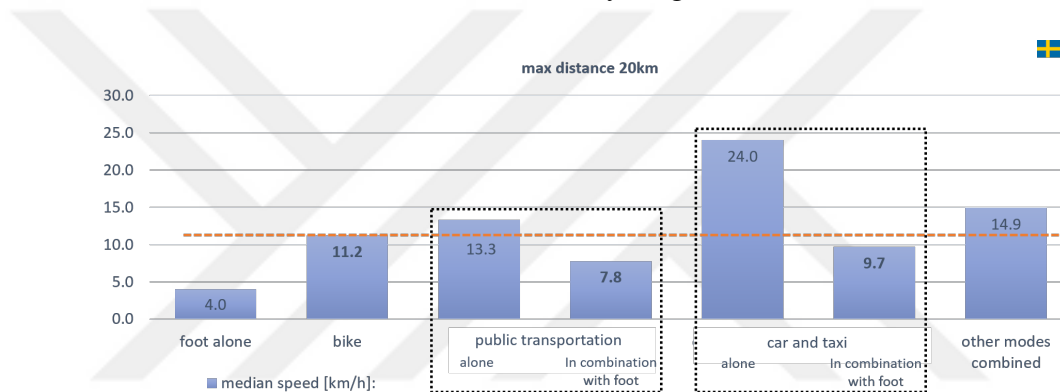


Figure 10.9 : Comparison of median speed depending on mode of transportation including multi-modal journeys for daily distances up to 20km. Data taken from all over Sweden

10.1.4 Separate strategies depending on modal share over distance travelled

After having identified the speed differences of transportation choices and the modal share of modes of transportation (MoT) in the VGR, the modal share is further narrowed down to its development over the total distance travelled on a day. This provides the opportunity to draw separate conclusions depending on the share over distance. The following graphs will present the development of the modal share over a range from 0 to 100 km travelled.

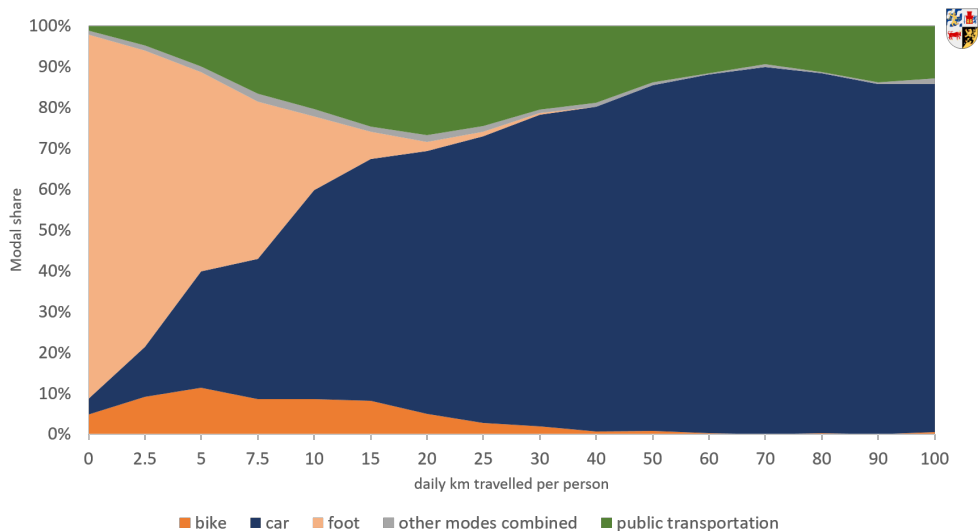


Figure 10.10 : Modal share in percentage over distance travelled. Data taken from Västra Götalandsregionen

This thesis aims at supporting an increasing modal share of cyclists in the city of Gothenburg. The modal share is intended to be taken mainly from individual car traffic as this MoT is most responsible for congestion and emissions. Figure 10.10 can be used to identify different strategies for this goal depending on the daily commuting distances of the end users. The separation was decided as follows:

For distances **up to 5km** a majority of journeys is already done on foot. The percentage of journeys done by car is very small and there is not a lot to be gained for cycling. Therefore these distances can be mainly neglected.

Distances **between 5 and 20km** see a rapidly growing share of journeys by car with a diminishing share of journeys on foot. Cycling is still used in this range, although slightly decreasing. This is where a lot of modal share could be transferred from individual car traffic to cycling. Daily distances **between 5 and 10km** can easily be travelled using a conventional bike. Distances **between 10 and 20km** can get more strenuous to some cyclists. Affordable electric bikes can assist in these cases.

In the daily commuting range **between 20 and 100km**, the majority of journeys are made by car. This range is especially interesting when planning to decrease greenhouse gas (GHG) emissions and congestion as this is where the biggest impact can be achieved. However, these distances are unsuitable to be replaced by cycling only. Already at the present stage the majority of cycling journeys are done for distances less than 20km. Other solutions need to be found. Our first suggestions point towards

an increased use of electric bikes and a seamless integration of cycling with public transportation to solve this issue. The proposed separation of commuting ranges including respective solution approaches is further discussed in section 11.2.

Figure 10.10 only shows the proportional share of the MoT's in percent corresponding to the distance travelled on a day. It does not indicate the overall sum of km travelled per respective daily distance. Therefore, figure 10.11 displays a stacked representation of the total amount of km travelled. The coloured areas in the figure represent the amount of km travelled, providing a better indication of how many km are travelled in total per MoT. The large blue area shows that the vast majority of km travelled is done by car. This indicates that the majority of GHG emissions by travelling stem from car travels between 7.5 and 100 km.

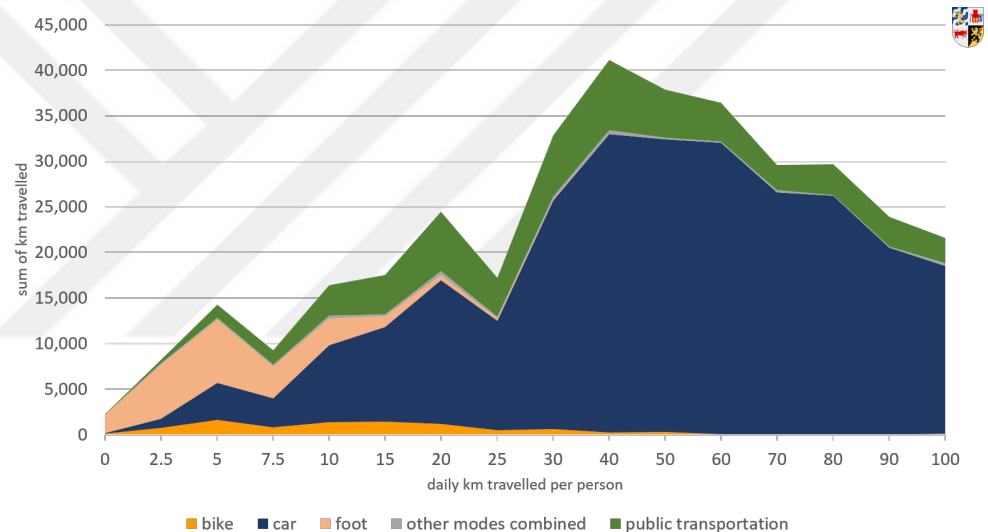


Figure 10.11 : Stacked modal share over distance travelled to display the overall sum of km travelled. Data taken from Västra Götalandsregionen

10.2 End user interviews

As introduced in the method section the interview questions covered four topics, namely background information, information about the motivation why the interviewees choose cycling, questions about their travel behaviour on the bike, and how they experience cycling. The results from the interviews are therefore summarised according to these topics.

10.2.1 Background information - "Who are you?"

The age of the interviewees ranges from 20 to 50. Except for one female, all the others were male. All of them live in Gothenburg. In comparison, all of the interviewees were between the age of three and nine when they learned how to cycle. However, learning to cycle around the the age of eight to nine was considered "late". As for the housing situation, the replies were of rather diverse nature ranging from apartments in the inner city to single houses in the suburbs of Gothenburg.

Whilst some interviewees replied that they had been cycling as a main MoT their whole life, some had just started doing so recently. One interviewee stated that they were not sure if the bike is their main MoT although stating that they use it whenever they are able to. There is one person who was in a specific setting in comparison to the rest of the interviewees. That person used to go by bike as main mode of transportation but stopped doing so when getting a child. This specific interviewee is at the moment looking for a way to change to the bike again and even bought a cargo-bike for that intention. However, they are still not able to make the final transition which made the case even more valuable for us to evaluate. All of the interviewees are using other forms of transportation as well, among these walking, public transportation (PT) or using a car or moped. Many still own a car or are members of a carpool.

10.2.2 Motivation - "Why do you cycle?"

When asked about when they first considered biking as main mode of transportation (MoT), the replies were mostly connected to major life changes that were ongoing at the same time. Those who have been considering it for their whole life mentioned a strong influence by their parents in their youth. Others mentioned economic reasons (*"In high school I had a free buss pass, so I used it. Then we moved and I didn't get a free buss pass any longer, so I switched to cycling. When you get a free buss pass you use it."*). Some mentioned starting to bike when studying due to not being able to afford other MoT. Two interviewees mentioned starting to bike regularly subsequent to having a baby. The move was in that case seen as either a final push towards an environmental friendly solution, or taking the children to school via public transportation (PT) would take too much time. The time that could not be used any

longer for exercising, so the decision was made to use the bike to exercise and commute at the same time. However, in around half of the cases the switch to using bike as main mode of transportation was done in small incremental steps. The bike was first used irregularly for short distances and then step by step the distance travelled, as well as the frequency of using the bike was increased.

Convenience was stated as one of the major advantages when using the bike. Mainly its flexibility when using it. It is always around and available, you can get anywhere with it and up to a certain distance it is the fastest way to get around. Especially if you have several places to go to on a day the bike was seen as optimal, because you can always go directly from one stop to the other without having to take detours, looking for car parking, or or having to wait for the PT.

All of the interviewees stated that the environmental aspect is an important motivation for them to use the bike. They all have a strong environmental interest and through biking even feel a stronger connection to the environment as they experience the nature more closely when on a bike as opposed to sitting in a car or in PT.

Only some people called it the most economical MoT. They especially mentioned not having the initial investment of buying a car and the running costs (*"the bike saves me from spending 30,000 Swedish Krona (SEK) a year"*). However, as many interviewees still own a car that economical advantage is not relevant to them. One interviewee mentioned that the *"car is maybe faster on longer distances but it costs so much to park"*. One person explicitly called cycling rather costly due to having to afford bike gear, clothing, and service (*"It is not free, it is not cheap - still it is cheaper than the car in most ways."*). According to them the economic entry level for a bike is relatively low but it can get relatively costly once you start investing in more advanced bikes and gear.

All of the interviewees mentioned experiencing a positive impact on their health and well-being as the major effect after starting to cycle. One person stated that *"Cycling keeps me fit and as long as I am fit I cycle"*. Cycling was stated to not only have a positive impact on the physical but also on the mental health. They are feeling better, cycling feels social, you can connect to your children and it helps to clear the head (*"You get the wind in your hair - it stimulates your mind"*). The physical exercise

also increased their well-being. According to the interviewees, the increased fitness lead to overcoming barriers such as cycling longer distances, being less exhausted by uphill cycling and sweating less during cycling. With increasing fitness and therefore increased range on the bike, the range for walking trips would extend as well. All mentioned that they are planning to still cycle when they will be 80 and see the regular exercise they get by biking as a way to make sure that they will be able to achieve that goal.

When asked to prioritise their motivations for using the bike, the replies were rather diverse. Whilst some mentioned the positive impact on the environment as important, others stated the speed and flexibility are the most important. The positive impact on the well-being was mentioned by almost all of the interviewees as next on their priorities. Only one person mentioned the financial benefits as one of the top priorities to choose the bike. Even more important is that except for one reply every one else mentioned several motivations as being in their top priorities. One person even mentioned that *"there needs to be more than one motivator"*.

When asked to classify their motivations to use the bike as main MoT into intrinsic or extrinsic factors, all of the interviewees mentioned that it was a mix of both. To some extent the society that they were living in and the acceptance of the bike had an influence on their choice as were environmental developments that could be identified in the outer world. However, it was still important to have a faith in the transportation solution themselves and identify the simple practicalities of it. Some people saw cycling as a part of their personality. Interviewees with children would also mention the inner belief to provide a better world for their children and teach them an environmental awareness.

10.2.3 Travel behaviour - "What do you do by bike?"

When asked about what kind of bike was used the range of replies were rather diverse. The following technical solutions were used:

- Old conventional bike in bad shape (so it would not get stolen)
- Foldable bike
- Cargo-bike (with and without electric assistance)

- Hybrid city-bike
- Mountain-bike
- Electric-bike
- Trailer on bike (occasionally)
- Tandem (rarely)
- Touring bike
- Velomobile (fully enclosed bike)

Some of the technical solutions were rather used for practicality, others also helped the interviewees to somehow express their identity by customisation. Some interviewees mentioned having quite a few bikes in their possession. Those were mainly old bikes that were left by their previous owners.

The journeys done by bike would encompass the following types of trips:

- Commuting
- Visiting friends and family
- Recreational rides (alone, with family, or as social interaction) and scenic journeys
- Long-distance bike trips on vacation
- Business related logistical trips
- Going to meetings
- Transporting children
- Going shopping
- First-/last-mile trips when using public transportation (PT)
- Other errands

A few journeys could not be done using a bike. These would include:

- Transporting the children to school because both the home and the school were on top of a hill and the cargo-bike would not have electrical assistance.
- Going with the children from the suburb into the city because the cargo-bike would not be allowed on the train and it would not fit in the elevator

- Picking up old relatives from the train station when they would come for a visit
- Moving
- When not having the time to shower at work before going to a meeting
- Carrying more that fits on a bike (eg. groceries) to the living place
- Carrying away large portions of waste from the living place
- Picking up children when short of time and having to go uphill
- When the bike was broken or stolen

The frequency of using the bike as well as the distances travelled would vary greatly in the responses. Some interviewees use the bike every day and up to 600km in a month, others two to four times a week and even some only once a week and in the winter only once a month. The commuting distance by bike varies accordingly. Whilst one interviewee does not use the bike anymore for commuting and another tries to commute by foot, the other replies varied from 1-5 km to 10-12 km to around 22 km one way. For some interviewees the distance they would travel by bike would also depend on the weather conditions. Especially for one interviewee there would also be a lower distance limit to taking the bike. That person replied that if going somewhere that is less than four km away without having to carry any items they would go by foot as it imposes even less effort than cycling.

When asked about when they would not choose to go by bike several reasons were named. Simply being too lazy could be one of them, too harsh weather conditions (especially in the winter) were named relatively often. One interviewee however, had a setting in which they would get paid by a sponsor when using their bike. This financial incentive was stated as playing a major role in motivating them to use the bike to commute long distances even in the harshest winter conditions (*"no one can trick me into saying that biking in [in Gothenburg] in January and February is something else than a sacrifice"*). Other reasons were that coming to a meeting soaking wet would be inappropriate, but also if the plan was to go to a formal dinner in a fine suit, if the trip would be too boring or they are planning to go drinking. Additionally under certain conditions such as the bike was not taken when being ill, the biking distance was considered too far away, there would be bad, unsafe biking infrastructure in between

(mainly next to highways or places where the proportions of cars to bikes would be too high on the car side and the car drivers would therefore not expect cyclists on the infrastructure). When using more expensive bikes available parking was an issue. They would need to know that there is safe parking at both ends of the trip. Especially when leaving an expensive bike somewhere over night would not be an option if there was no safe parking available.

When asked about their behavioural shift, none of the interviewees stated that their travel behaviour has radically changed since they shifted to the bike as their main MoT. However, some smaller changes were mentioned. For example if going out for amusement trips the distance would be chosen closer to home. Others mentioned still going to the same places but taken different routes instead (for example using the ferry to cross the river instead of using the bridge when driving a car). One person mentioned that buying an electrically assisted cargo-bike drastically lowered the threshold to bring their children to kid's sports activities under bad weather during the winter. That person also mentioned that when doing activities with friends of their children they try to advertise different MoT than the car, eg. taking the train instead, even for longer distances.

10.2.4 Barriers and drivers - "How do you experience cycling?"

Cycling infrastructure

Firstly, they were asked about their access to cycling infrastructure and complimentary facilities. All of the interviewees stated that they have direct access to cycling infrastructure in terms of bicycle lanes or streets that could be used for cycling. One person explicitly stated that access to a separate bike-lane was not of importance to them as *"you can use the bike everywhere"*. Some interviewees stated that they would use either of the street or the bike-lane, whichever would be faster to use. Another, but far more important issue for most of the interviewees was stationary cycling infrastructure in terms of parking facilities at home as well as at work. Except for the one interviewee who used an old and cheap bike everyone mentioned safe and sheltered bike parking as being very important. One person would even park their car outdoors and park their bike in the garage instead. Some interviewees would own or rent car garages or private storage rooms, even with indoors heating facilities, for easy

maintenance of the bike during the winter. Everyone with a more expensive model mentioned that they would try to avoid leaving it outside over night because of the possibility of it getting stolen or damaged. Simple bike-stands would not suffice to lock the bike safely, including locking the frame to the stand as well. Most of the interviewees would have this kind of parking at home, but not all of them at work. Several interviewees also mentioned other infrastructure at work that can help a cyclist. This would include having access to showers, a pump for the tires or even some tools or material to fix tyre punctures. Only one person would leave the cargo-bike outside -on their own lawn- stating that the neighbourhood is safe.

Challenges

When asked about the challenges they face when cycling, the following factors were mentioned: wind, rain, cold as part of the weather (*"In the winter it is not so great - it has been a struggle"*), punctures as technical failures, and sweat as related to personal appearance. Stolen bikes were mentioned as part of societal incidents. A few interviewees mentioned that living in a city that has a long tradition in the automotive industry provides a societal opposition to using other MoT. The society seems to be more focused on the car as well. One interviewee questioned the large effort as well as funding put into the development of environmentally friendly cars as opposed to prioritising cycling (*"How many cyclists would be happy to receive 40,000 SEK to buy a better bike?"*). The question was raised where people would complain more, if infrastructure for the car or for the bike would be taken away. According to the interviewee people would complain more if infrastructure for the car was taken away. This is also due to the fact that the bike is less infrastructure-dependant. Riding the bike in the inner city as opposed to the countryside was also mentioned as being less enjoyable: The bike lanes were confusing and you could encounter other people in the way that you had to go around (*"With a good bike you can speed off like crazy but then you have to watch other pedestrians or cars"*). Sharing the cycling infrastructure with pedestrians was criticised by some interviewees, others saw this as a good solution in order to make the different modes of active mobility (AM) respect and look out for each other. In that context the Netherlands were often mentioned, where cyclists and pedestrians share more spaces and there seems to be a better interaction between the two in terms of social acceptance. Sharing the infrastructure with cars (Cykelfartsgata)

was not perceived well for most of the interviewees. However, this was mainly due to bumps used to slow the cars down. These were lowering the convenience for cyclists even more and lead to the cars actually being slower than the bikes (less fluent flow of traffic). Instead a general speed limit of 30 km/h was proposed. Another reason for criticising it was that the cyclists would have to breathe the exhaust fumes of the cars in front of them. The same issue was mentioned when using a cycle-lane next to a highway. Existing cycle-infrastructure was often criticised as not properly thought through. Many mentioned that they had the impression that the infrastructure was not designed and built by people who cycle themselves, that the end user was not in the centre of the planning. Others mention that in terms of planning, the car is still prioritised over the bike, a lot of time the roads for cars were given more space, more direct routes, and they were in a better condition. Especially in some central traffic hubs of the city the cycle infrastructure would suddenly disappear or be directed towards a detour. Unlit cycle-lanes were criticised as being unsafe to use, especially in the winter. Crossing the river was also difficult, especially because the ferries for cyclists and pedestrians do not operate outside office hours. Particularly the combination of cycling and PT was considered difficult. In most cases it was not allowed to take the bike on the PT eg. after having a tire puncture or when not feeling well. Many stated the wish to be able to take the bike on PT outside of the rush-hours. The local bike-pool was also criticised for not having stations at the places that they would need them to be and being too complicated to figure out how it works. Additionally, it was criticised that one cannot use it with your children and that after using it for longer than 30 min it would get really expensive. However, many interviewees stated that they have seen improvements in the cycle-infrastructure provided over the last years.

Other difficulties were faced with the actual biking gear or the cycling itself. Clothing would malfunction, the insurance for the bike was not as convenient as for cars, and fully safe bike locks were not available on the market. A repair shop would also occasionally be needed in order to maintain the bike properly. Outside of the winter for some a pollen allergy could make cycling more difficult. One interviewee mentioned getting their bike stolen once a year, which is the reason for why they only possess an

old and cheap bike. Owning a rather unusual bike would also pose some problems to some of the interviewees.

Discussing the topic of overcoming these issues the following tactics were mentioned: especially the weather issue was rather described as a psychological threshold. In order to overcome it the best protective clothing was acquired and having this clothing with them all the time meant overcoming this barrier. Another person used a fully enclosed bike to overcome the weather issue. Several interviewees mentioned reporting infrastructure issues to the city, especially after an app was created serving that purpose. Others did not feel the urge to report their issues anywhere. Stolen bikes were only reported in order to follow up with the insurance companies. There was little trust in the police following up on the theft.

Suggestions for promoting cycling

The following factors were mentioned making a conversion to cycling easier: Technical solutions that came up in the recent years such as the electric bike or a cargo-bike made a conversion to cycling easier. Although to some people in society the electric bike (e-bike) still symbolises making cycling too easy, it can surely lower the entry-level threshold to more people who rather see it as a means of transportation (*"It feels a little like cheating or the e-bike is only good for old people. The image is that cycling has to be tough."*). However, especially for a new technical cycling solutions, it helped to have a retailer close by. This enabled the interviewee to test-drive, discuss the bike in their mother tongue, and have a maintenance-service close-by. Cycle infrastructure at the workplace such as safe parking, showers and lockers or bike pumps, has improved for some interviewees. Giving away electrically assisted bikes for people to test them for a specific time period was also mentioned as beneficial. On a similar level it would help to upscale the existing bike-pool, using electric bikes to extend the range of the users. Having a large battery to assist helped in extending the range and therefore lead to the bike being used even more. However, another interviewee mentioned the threat incorporated in electrically assisted bikes, which is that they are harder to be fixed by non-professional people and non-functioning batteries might pose an environmental threat in terms of disposal. More advanced technical solutions such as the cargo-bike were mentioned as having a positive promotional effect on other people in their surrounding. Neighbours would

ask about the bike and the interviewee mentioned having identified a growing number of adopters in their surrounding. For people who live in the suburbs of the city a high-speed cycling-network would enable more cyclists. Another way to attract cyclist that was suggested would be to establish more clearly advertised scenic cycling routes for recreational use.

Moreover, a general decrease of the maximum speed for cars inside the city to 30 km/h was mentioned as an easy fix to provide a safer space for cycling and make the traffic flow as a whole more efficient. Giving more space to cyclists in terms of making the cycle-lanes wider would make cycling more convenient. However, a clear separation of the cycling infrastructure to other modes of transportation (MoT) was criticised by one interviewee as it creates *"traffic apartheid"* in which different actors within the traffic flow would not learn to pay attention to each other (*"It's a city, we have to share the space"*). On a societal level it would help to teach and encourage children (and their parents) to cycle to school (*"If you want to triple cycling, you need to focus on the kids"*

In addition, it was stated that role models, who publicly present themselves cycling would help a conversion as well. In Denmark even the royal family can be seen using a bike. Some interviewees mentioned that the social acceptance of cycling has risen slightly. For some people it is even becoming trendy to cycle (identification with the MoT). However, according to several interviewees this might mainly be a phenomenon on the middle- and upper-class. Therefore the bike should be brought to the center of attention to all spectrums of society. Especially in the current debate about terrorist attacks using trucks it was mentioned that a general ban of lorries in the inner city in combination with a logistics solution on bikes could raise the safety level. Two interviewees mentioned bottom-up initiatives such as the existing bike kitchen (where one can acquire a bike, previously disowned by its former owner. As part of the local sharing community, those are currently available in available in Centrum, Gamlestan, Norra Biskopsgården and Södra Biskopsgården districts (Cykelkok.se 2017).) or cycling lobbying events as another way to support a transition towards biking and show society that it is a transition that is requested both on the political level, but also within the civil society. In connection to that, the recent governmental decision in Sweden to reduce taxes on repairs is said to also have a positive impact on people

taking better care of their bike (*"A bike is not used when it stored old and rusty in the basement. It has to be in good shape to be used"*). Tax reduction was also mentioned when discussing that the commuting journeys by car or PT can be deducted in the tax declaration whilst journeys by bike cannot.

Improvements on well-being

When asked about the major benefits they experience from cycling all mention a great positive effect on their physical as well as mental well being. One person mentioned that it *"eases the constant feeling of guilt which was caused by the negative effects of driving a car"*. All 11 interviewees mentioned feeling less depressed, clearing their head and feeling psychologically stronger because of the everyday motion. Some people mention being more imaginative and inspired since biking and having more energy to start new projects. For some it has also opened new social engagements and they met like-minded people that they would not have interacted with if it was not for biking. Strength and physical fitness has also improved as has their stamina, which even increased the range they could go by bike. Fitness was especially mentioned by people with children as they have little time for exercising but even have a stronger need to be fit in order to take care of their children. In context to the improved well-being by cycling it was mentioned if cycling could somehow be supported using the Swedish wellness grant (Friskvårdsbidrag) that is used to keep Swedish employees fit.

10.3 Local cycling initiatives

In order to understand what is done regionally for the extension of cycling, several regional sources were analysed. The Gothenburg cycling strategy for 2025 functioned as a basis, on top of this local stakeholders were interviewed and a design workshop was conducted. The results are presented in the following.

10.3.1 Gothenburg cycling strategy

Published in 2015, the Gothenburg cycling strategy is a follow-up to the cycling strategy, which was developed in the year 1999. The major points are summarised in this section. The strategy is based on a traffic survey from 2011 shown below on figure 10.12. The set goal for the next ten years (until 2025) is to triple the amount

of bicycle journeys in the city on a day. The number of bicycle journeys in 2011 was 73,000 which was equivalent to a modal share of 6%. Due to the predicted growth of traffic until 2025 a tripling of the number to 219,000 journeys would result in a doubling in the modal share to 12%. It is important to note that these figures are for the counts of journey. In terms of km travelled, it is much lower modal share for bikes. Furthermore, the figure 10.13 depicts the strategic goal of modal traffic share in 2035.

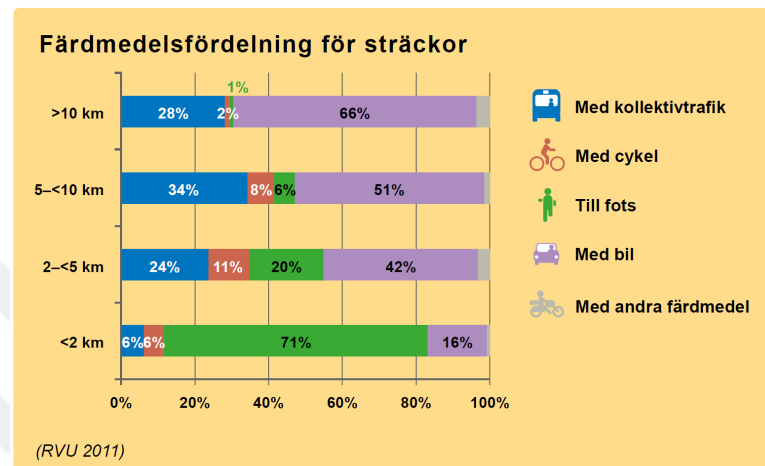


Figure 10.12 : Modal share over distance in 2011 (City of Gothenburg 2015, p.25)

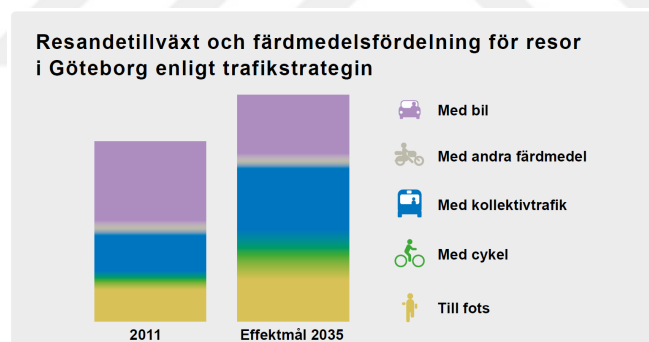


Figure 10.13 : Strategic goal for the modal traffic share in 2035 - (City of Gothenburg 2015, p.22)

The second goal is to achieve that by 2025 75% of the citizens of Gothenburg think that Gothenburg is a cycle-friendly city. This is followed up as an index of attractive the respective modes of transportation (MoT) are as well as how locked-in the end users are into their MoT. One is an investigation of the modal traffic share over the distances travelled which in 2011 provided similar results to our findings.

In the cycling strategy document, other cities are being looked into, in order to get further inspiration on how to support a transition towards more cycling. The major learning points from the other cities are summarised by the following:

- A fine-meshed and well developed network of cycle lanes
- A clear separation between pedestrians and cyclists
- High-quality parking facilities
- High integration with public transportation (PT)
- Restrictions for car-traffic
- A proactive dialogue with the cyclists

The cycling strategy therefore defines four areas of actions that will be used to fulfil the goals in the Gothenburg case:

- Infrastructure
- Operation and maintenance
- Support and Services
- Communication

Within each area more detailed goals are set. They are described in Appendix B.

10.3.2 Expert interviews

As previously mentioned in the method chapter 9, during the expert interview stage, the ongoing projects and the momentum are identified by interviewing the experts from triple helix structure in an unstructured setting. The interview outputs are given below.

Local transportation office "Trafikkontoret" interviews

These interviews were conducted with two experts in two separate occasions to have more information about different projects. During the first interview, the project responsible has indicated that in order to keep track on the cycling development, they are conducting attitude surveys and an inventory for accidents. They claim that the count of accidents have gone down, however there is a clear division between how people perceive safety and how safe it actually is. They are currently analysing this discrepancy. When they were asked where they see the potential to increase cycling, they have stated the majority of new cyclists would arrive from public transportation (PT) users. They are currently collaborating with academia on models for bikeability in the city of Gothenburg.

Furthermore, they mentioned the river as a main barrier in Gothenburg. Additionally, when they were asked about projects that cross the river, more specifically the cable-car, they have stated that they are currently examining the possibility of physical cycling integration (e.g. taking bike on cable-car) and how would be the payment plan for end users, in case there would be a physical integration. They emphasised that the ferries operated between the two sides of the river serve cyclists, allowing them to cross from one side to the other.

Moreover, they mentioned that the expansion of the city-wide bike sharing network is at planning stage and could be implemented no earlier than 2020. They stated that their main focus is on private bike ownership, rather than a shared system; they indicated that sharing system (also for cargo bikes) would be more feasible if operated by real estate companies. They stated that e-bikes are quite helpful for commuters and that they are currently examining a high-speed cycling network, as well as improving the existing one.

In addition, they stated that only a fraction of actual situation shows up in the statistics as many people do not report about the issue of theft. However, they are planning to build a secure bike parking at the train station. Furthermore, they are developing a guideline for providing a secure parking space and a strategy to support the housing companies to build secure spaces.

They also mentioned the movement to create cycle friendly workplaces and the need of guidance. However, they mentioned the taxation obstacle in case the employer provides bikes to the employees, which needs to be solved at the national level. They have stated that the road constructions around the central city is an opportunity to introduce more people to cycling and that they started e-bike trials for people who work in the construction zone. When it comes to other local mobility barriers, they have stated that the satellite structure of the city (districts that were formed once as suburbs that now are part of the urban area) makes it harder to commute by bike, due to long distances, topography and the river. To overcome the barriers they have focused on the improvement of PT and thus cycling was not prioritised. When they were asked about the bikes being allowed on PT, they stated the concerns of safety, time constraints in terms of boarding the bike, and they mentioned that on the regional buses, it is possible to bring bikes.

During the second interview, they mentioned the e-bike trial projects that they have initiated. The projects encompassed two cycles of three months each. The first cycle was done in winter whilst the second was ongoing in the summer parallel to the writing of this thesis. In each cycle 200 bikes were given to applicants following a selection process. The target group consisted of people who would commit to use the e-bikes given instead of using their cars to commute at least three times a week, working in central zones that are highly affected by projects Hisingsbron, Västlänken and E45 corridor. They were provided different types of bikes, as well as maintenance service according to their age, height and condition level. The projects were followed up upon by using weekly journals about the participants travel behaviour and questionnaires that were handed out at the start and end of the cycle.

At the end of the first cycle, they were given the opportunity to buy an e-bike for themselves or people they know with 30% discount on regular price. 105 e-bikes were sold. As major advantages they stated that they were not tired or feeling sweaty while commuting, with the help of electric assistance. They felt more connected to the nature, have less impact on deterioration of the nature, more empowered as they were able to pass the cars queuing on the streets and that they no longer needed to look for a parking space, and finally not having to pay for fuel and congestion charges. One participant was commuting as far as 15km each direction. The participants expressed being surprised by how easy it was to commute by e-bike.

Major difficulties as reported: lack of directions for where to cycle, construction sites causing disruptions, conflicts caused by mixed use of infrastructure by pedestrians and cyclists, bike lanes being slippery with fallen leaves from trees during autumn. Seven people quit the project due to weather conditions and seven bikes were stolen (out of 200).

They state that the project is perceived as a "feel-good" project to build trust in society during the major infrastructure construction phase. To rid of 200 cars for three months is also important. They indicate that the quality of the bikes provided were important, however it is not possible to place any stickers or indicators on bikes due to commercial laws.

Parking solutions provider interview

One interview was executed with two representatives of a private parking solutions provider. Although the company is a privately run business it is owned by the city providing it with income. During this interview the representative of the parking provider mentioned that they are currently running two secure bike parking areas. The project is at trial stage and that they are examining ways to enhance the parking services together with the local traffic office, mainly focusing on business models. They stated that they will build more parking spaces when they see a clear demand but the occupancy rate of the current projects is quite low. They stated that the current projects are monthly subscription based, not profitable and the willingness to pay for bike parking is too low, based on studies done in Malmö and Copenhagen. The current demand is coming from the public authorities, not from the customers themselves. They pointed out that they have not followed consumer behaviour, in terms of subscribers using the parking space for commuters or permanent parking. They mentioned the momentum of creating a bike parking space in the ferry terminal, Saltholmen and the project specifications are still unclear.

The representatives further stated that they want to support all kinds of mobility demands, not only one. They explained that they see the tenants in residential areas as primary customers, while visitors and commuters from outer city are secondary and tertiary; but they are serving all three groups. They pointed out that planning at the larger scale was neglected throughout the years, focusing on detailed plans, however they are shifting this tendency. When we asked them about their pricing strategies, they said that there is no consensus between public authority and service provider and they are negotiating on a pricing strategy. They further said that they do not operate on subsidies, and that profitability is a key element to expand. When we asked them if they see any possibility for offering shared cargobike solution, they raised the debate of people wanting to keep such a bike as close to their residence as possible. They also expressed their concerns about prices going higher due to increasing land value.

The national transport administration authority "Trafikverket"

During this interview they said that the definition of the problem is important in order to understand the situation: Instead of focusing on sustainable transportation, one

needs to focus on having good accessibility in a sustainable city, more importantly on the social aspects of sustainability. Additionally, they mentioned the Uppsala case, where the environment encourages the people to cycle more versus Gothenburg case where priority is clearly given to other modes of transportation (MoT) and not cycling. They explained that in order to encourage active mobility (AM), the city needs to be restructured while keeping the current PT at a reasonable service level. Additionally, they indicated the importance of physical separation between pedestrians and cyclists, provided with softer, "forgiving" surface layer; and lanes that are sheltered from weather conditions. They mentioned the Torslanda part of Gothenburg where bike lane is situated exactly next to the highway, which reduces the perception of safety, as well as well-being of cyclists due to tail-pipe emissions, dust and noise levels.

The regional planning office "VGR"

During this interview they expressed the difficulty of understanding how bike-train integration works and the reluctance in serving more than two bikes per train wagon. They stated the need for finding indicators to prove the advantages of cycling and their bike friendly company awards, where the winner gets to be advertised for free in the cinema. When it came to the local bike sharing system, they mentioned that other business models might be more beneficial, and the expansion to other cities in VGR would be feasible. They stated that their main goal is to double the number of public transportation (PT) users, however cycling is also considered beneficial. They observed the change of people's travel behaviour if they are going through changes such as; moving somewhere else, changing workplace, having a kid or moving together. They expressed the need to provide bike parking space in train stations of other towns in the VGR.

In addition, they indicated the ongoing project of foldable bike trials where 20 people are selected to try them for 3 months period, with a license to prove that it is allowed to take a foldable bike on any kind of PT to raise awareness. The only condition is that people who signed up have to cycle at least three days a week to work using the foldable bike provided. In the beginning of the project they would offer check-ups to observe the participants' well-being. The bikes are provided with maintenance contract, meaning any kind of disruptions will be fixed by the service provider.

10.3.3 Stakeholder workshop

As previously introduced in the chapter 9, method, the stakeholder workshop covered all four layers of our MDM:

- Societal system,
- Socio-technical system,
- Product service system,
- Product technology system.

The results obtained from the workshop are delivered under these layers, respectively.

Societal system

Some of the stakeholders mentioned that the education system is influential to introduce more people to cycling. When people are introduced to cycling at an earlier stage of their lives, they will carry on the "healthy" life, therefore they will keep this as a habit as they grow older. There was a consensus about why people should be introduced to cycling at early age. Another way to promote cycling at the education system would be the introduction of "cycling sports" to raise the status of cycling to a higher level. Furthermore, the education should not be limited to only cycling and balancing, but include other cycling related skills such as way-finding and repairing. One even mentioned that there should be a driving license like "cycling license".

They expressed the need for increasing the acceptance of all types of transportation. Implying that cyclists have a negative image as careless individuals, one mentioned that *"the negative image of cyclists should be changed"*. There was a clear consensus about raising cyclists awareness towards their surroundings, meaning that they should be more alert to avoid conflicts with pedestrians while cycling.

Social segregation was another issue that came up during the workshop. One stated, *"we need to make sure that all kids have access to a bike so it will not become a question of social class"*. Furthermore, another stakeholder mentioned the need of introducing cycling to groups that are not cycling today. This could lead to improving their health, economic status and give them access to a larger geographic area. One stated that *"It should be seen as everyone's right to cycle. [They] should be able to deliver free bike education to everyone through the municipality"*.

Socio-technical system

While expressing their ideas about the socio-technical system, they mentioned that with a good combination of regulations and infrastructure, making it more "difficult" and expensive to drive one's car, making the competition more fair for bikes. Another added that while driving is made more difficult, cycling should be made easier to encourage the "right do-ers". In addition, the need to own a car should be minimised through directing people to carpools. To raise the fair competition, one also added that the investments should be done equally for cycling infrastructure and car infrastructure.

While mentioning the regulations, they criticised the "free school choice" reform, which causes the pupils to go further distances than they should, in order to reach the education facilities. They mentioned that having signed up to a closer education facility would generate more bike trips (instead of generating trips for other modes of transportation (MoT)) as the distance that needed to travel is shorter. As the subject of parents dropping the pupils to their education facilities came up, one strongly stated that *"The kids should not be dropped off by car at school. Walking, cycling or the public transportation (PT) should be the only options."*, criticising the parents' behaviours. A suggestion for solving the longer trips generated due to education system was that the city should be denser, resulting in shorter distance to functions such as educational facilities. Car parking options in the inner city should be reduced, especially the on-street-parking, and these areas should be transformed into bike-lanes, bike parking areas or even green spaces. Another stakeholder suggested that the cars should be completely forbidden in the inner city area, making it only accessible by active mobility (AM) or PT. A reaction to this suggestion was that, however it may not be possible to enact a total ban on cars, they may be allowed to reach everywhere by decreasing their speed substantially and with a clear prioritisation of AM and PT. This system would be the solution which has already been applied in some areas of the inner city, as the "walking-speed" streets. It was however also brought up that this would be against the freedom of choice, stating that *"some people do not want to cycle due to different reasons; age, disability or simply being afraid of cycling in the city."*

Positive incentives were seen as an important driver to make people cycle more, instead of preferring another MoT. One way to carry out the incentives would be making it possible to get a tax refund (since cycling is not entirely free) for commuters who

cycle (or use other sustainable MoT) to work, which is already possible for commuters who drive their cars. In addition, many suggested that at their workplace, "company bikes" should be available via leasing, as there are "company cars" available today. That the employer should pay for the service and other potential costs. Another way to incentivise would be, instead of giving away public transport pass, they should be able to subsidise their employees' bike related costs without being taxed.

Additionally, one stakeholder stated while criticising the current incentives, that either there shall be no free public transport passes for pupils, or that it should only be allowed for pupils who have no other option and live too far from their educational facility.

The importance of short trips to establish a cycling habit in the society (especially for people who never cycle) were stated several times during the workshop. Furthermore, to make cycling more attractive amongst PT users, a combined PT and bike-share subscription could be implemented.

Data collection was brought up during the workshop. They mentioned that the data for cycling traffic should be collected at the same level as they are currently doing for car traffic. The traffic flow, speed and congestion data needs to be collected to develop the system better. This would raise the safety level for all active mobility (AM) modes, and their comfort level.

Product-service system

When it comes to product service system, it was a clear consensus that the need for prioritisation of cycling over road network should be addressed. They need to be planned way ahead of car roads, and the current width of the roads could be decreased where it is possible, to make space for wider bike-lanes. Wider bike lanes would allow people to cycle side-by-side and taking over safer. Moreover, they would fit in serving for more than one type of bike and cyclists (as in super-cycle highways). Another stakeholder mentioned single lane traffic, where the cyclists can only go in one direction, would be beneficial for safety as well. As previously mentioned in societal system, there was no consensus in separation from pedestrians. However, one commented that in central parts of the city, shared solution between cyclists and pedestrians would be a safer, slower alternative, while separated lanes would serve for longer distances. Reaching a more respectful environment would result in welcoming

more new-cyclists. In order to get there, there needs to be a social contract between pedestrians and cyclists, where cyclists need to reduce their speed. When needed in city centre, the space for separate bike lanes could be derived from former on-street car parking areas. The parking lots should be placed in remote locations, making the other MoT (both PT and AM) more viable and time efficient. Instead, secure bike parking areas should be implemented where the demand is higher, such as in central business areas, educational facilities and transportation hubs. The prioritisation of cycling should also be supported while regular road network maintenance. The space needed for maintenance should not be cut from bike-lanes, which would cause more disruptions.

One stated that *"[We need] an infrastructure that is safe and easy to bike **everywhere** for **everybody**."* Emphasising the driving force of the infrastructure investments. These investments could be redirected from the budget for car infrastructure, as another stakeholder specified *"today we build car infrastructure for billions of SEK, but we are not willing to invest in bike infrastructure"*. They also expressed that, to create a seamless connection between PT and bikes, a combination of solutions is needed e.g. to:

- be able to take more than two bikes at once on trains,
- be able to take bikes on all types of PT on off-peak hours with an extra charge,
- secure parking facilities with a subscription,
- provide an extended bike sharing network that covers many parts of the city and is easy to reach.

Product-technology system

In the product technology level, they commented on the clear advantages of marketing. One brought up having more cyclists and bikes roaming on the streets would normalise cycling as a proper MoT, and that try-a-bike programs have quite an impact for convincing more people. Furthermore, the marketing of currently available technologies (cargobikes, e-bikes, foldable bikes, and solutions for bike locking, where it will be impossible to utilise a bike if the person is unauthorised). For visitors a bike rental program that also covers the PT would be beneficial. One stakeholder suggested that a free-floating bike sharing system where no stations are needed would

make cycling more flexible and convenient. Furthermore, some stakeholders discussed that a sharing network for cargo bikes or bike trailer at housing areas would reduce the need for cars and increase the cycling share as well. The costs of such a system could be included in rents, as "laundry-room" like solution. Some stakeholders further indicated that a system with subscription could also include bike maintenance services as well as a space to having one's groceries delivered.

One-way trips such as dropping off one's kids at school and multi-modal trips were mentioned several times at this level. All the PT stations should be suitable for safe and secure parking, which could be provided by covering the premises with a roof and/or camera surveillance.





11. DISCUSSION AND CONCLUSION

In this section the findings delivered in the results section are synthesised and discussed within the framework of the multilevel design model. Furthermore, an action plan for upscaling cycling is presented. The studies are concluded with areas to focus and recommendations for further studies.

11.1 Analysis of identified issues

A lot of output can be taken from the quantitative and qualitative results obtained including many detailed issues, problems and solutions. However, six major issues were extracted from the overall results and are discussed in the following. Many of them are connected to several levels on the Multilevel Design Model (MDM). Therefore, actions to deal with these issues will need several actors on different level to intervene.

Cycling as a solution for sustainable urban mobility. As mentioned before, urban mobility is facing many challenges in terms of pollution, congestion, inequality in mobility standards, etc. Cycling proves as an effective counteraction towards the aforementioned challenges. The awareness for this is rising, especially for politicians and urban planners, and results in many enthusiastic goals and strategies with some cities such as Copenhagen or Vancouver at the forefront of this development. Gothenburg -despite carrying the legacy of being "the car city"- as well has set ambitious goals in this field. The cycling strategy of the city was taken as a guideline for this thesis. However, as identified in the results, the ambition level of the set goals and the actions taken in order to fulfil these do not always match. If the goal is as ambitious as tripling the number of cyclists in the city within ten years, the actions following this goal have to be as clear and directing. Business as usual with just minor changes will not lead to such a drastic change in traffic behaviour. If the modal share of cycling needs to rise, so does the prioritisation of it in infrastructure programmes, communication strategies, and development programmes.

Unawareness of benefits from cycling. Drawing from the modal share of cycling in urban traffic, the advantages of cycling seem to be unfamiliar to a majority of end-users. Many of the advantages are only perceived when already cycling. The identified advantages of cycling - may it be the improvement in physical and mental well-being or the speed advantages in multi-stop journeys - seem to be unknown to a majority. Even more importantly, some prejudicial disadvantages of cycling have been proven inadequate by this thesis. These include that cycling is actually faster than using public transportation and similar in speed to driving by car when taking the whole journey from door-to-door into consideration. Additionally, the perception of bad weather, tiresome long distances, or steep hills have been proven inadequate or easily surmountable with the adequate training or equipment.

Prioritisation, safety and security of cycling in urban traffic. Probably closely connected to the aforementioned ambition level from politicians and urban planners, cycling appears to still be neglected in comparison to other modes of transportation (MoT's). There is a clear need for prioritisation in traffic in terms of properly maintained and direct lanes, increased urban space devoted to cycling, bridges, tunnels, ferries, cable-cars to cross the river with a higher frequency. The cycling infrastructure should be designed to regulate the flows (e.g. mixed traffic in city centre and separate lanes in less congested areas). Furthermore, the integration with public transportation (PT) is neglected. Except for several trains there is no possibility to take bikes on PT and the bikesharing network is comparably small and complicated to use. Cycling and PT integration should be supported by allowing bikes on other means of PT such as trams and buses, where applicable. With the introduction of smart bike locks, the bikesharing network can be upgraded to a free-floating system, accessible by smart-phones. The safety of the existing cycling network should be sustained with regular maintenance and supported by street lights in every section. Additionally, the alarmingly high number of bikes being stolen seems to be neglected. As this security issue will even become more pressing with a growing number of expensive bikes on the street, counteractions need to be put in place. This is closely connected to providing secure parking - e.g. with a simple set-up with surveillance cameras, especially near major PT hubs - but also with proper follow-up on thefts by law enforcement.

Separate strategies for different commuting distances. To increase cycling there is no "one fits all" solution. As shown in the quantitative results different strategies need to be employed for different commuting distances. Although cycling is perceived as especially easy on short distances and some have claimed this as a commuting distance to focus on, the results show that in this field there is little to gain for cycling. If cycling is set to be drastically increased, it needs to be supported on longer distances. This is, where a large share can be taken from other MoT's and this is, where the majority of greenhouse gases are emitted from individual car traffic. Especially for the longer distances, there needs to be a focus on e-bikes and the integration with PT. Those are further elaborated in section 11.2.

End-user conversion. As mentioned before, many end-users have to perceive the advantages from cycling in order to be aware of them. Therefore, the question rises how to make end-users switch to this MoT. Here, several factors can come into play. Similar to the previous paragraph, focusing on short distances will have little positive effect. Making people switch from walking to cycling is not the desired outcome. Therefore a focus needs to lie on longer distances. Regardless to the commuting distance, focusing on youth is one way to convert end-users. Young people are usually physically fit and not as attached to their MoT as older people. As Gothenburg is hosting two major universities and the country has seen a growing number of young newcomers in the last years, adolescents represent a large target group in the city. Additionally, they will be the commuters of the future. As seen in the qualitative results, giving a push to non-cyclists by providing try-a-bike programmes, has proven successful. To raise overall mobility of residents, cycling can be used as a powerful tool via providing lessons and expansion of bike kitchens "Cykelköket" (see section 10.2.4. More of these programmes can actively push a development to increased cycling instead of having end-users draw themselves to this MoT.

Necessity of a dialogue. As identified in the results, many goals, initiatives, and programmes exist in order to increase cycling in the city. Some of them work from a top-down perspective whilst others are bottom-up initiatives by the civil society. All of these include a large number of actors. A stronger collaboration between all of these actors can result in synergies creating an overall improved effect. Using the Multilevel Design Model assists in analysing different activities and actors on different levels

and indicates how they are interrelated. Opening a dialogue platform with regular exchange of knowledge can aid these actors to collaborate rather than coexist and therefore jointly work for the common goal to increase cycling.

11.2 Promotion of mobility solutions based on distance of journeys

As seen on the travel statistics in section 10.1 on page 53, in terms of speed cycling is mostly inferior compared to the speed of cars or public transportation (PT). However, the survey also shows that only a small portion of journeys by car or PT is done using only that mode. A rather large part is done in combination with journeys on foot (the first / last mile travelled). This in combination with the large advantages of active mobility (AM) on multi-stop journeys evens out the speed advantage of other modes in urban regions.

The results obtained in the Resvaneundersökningen - Swedish travel survey (RVU) chapter 10.1 figure 10.10 on page 60 have shown that there is a large potential for the expansion of AM and PT based on the distance travelled on a day. Our proposal to focus for promotion are:

- For shortest journeys - which are below 5km:
 - Cargo-bikes, if there is dropping off one's child to educational facilities or hauling of goods such as grocery shopping involved.
 - Walking, for the cases that were not mentioned in the previous case.
- For daily journeys between 5-10km:
 - E-bikes, if there are steep hills involved on the course of journey.
 - Conventional bikes for the other cases.
- For daily journeys between 10-20km:
 - Electrically assisted cargo-bikes, either there are steep hills, dropping off one's child to educational facilities, hauling of goods such as grocery shopping or a combination of one of these conditions involved on the course of journey.
 - E-bikes, if there are steep hills involved on the course of journey.
 - Conventional bikes for the other cases.
- For journeys longer than 20km:
 - Public transportation (PT), with a seamless integration with cycling.

However, it should be considered that all the results are assumed as the most frequent journey that individuals cover weekly. Therefore, the validity of the assumption can be discussed for further studies.

Evaluation of data collection methodology

As presented in the results chapter (see figures 10.1 and 10.8) the evaluation of speeds of each mode of transportation (MoT) should not be done based on time spent on car and PT alone, but door-to-door. By doing that, the time spent on foot to get to the nearest available parking spot or public transportation (PT) stop are included in the actual speed for each mode. This provides a fair comparison basis for all MoT'S (e.g. for people travelling only by bike or on foot for the whole journey, as bike parking - although not necessarily secure parking - is widely available at the entrance of commercial and residential buildings; and pedestrians do not have to change modes). This makes active mobility (AM) (especially cycling) more convenient for short trips over driving a car, as motorists have to find a parking spot at each end of the trip.

11.3 Proposals for actions to be taken to increase the modal share of cycling

In order to reach the goals stated in the cycling program, and raising the modal share of cycling even further in the years to follow 2025, our immediate action plan proposal includes several measures that are explained in the following. They are put into context with major ongoing developments in the Gothenburg region creating an indication of when they could be implemented. The proposed measures are:

Communication of the already existing benefits of cycling on the well-being of the cyclist can be a "low-hanging fruit" to increase the cycling movement. It can be done via marketing campaigns, event organisations and collaboration with other actors involved in the fields of sport and well-being. Marketing campaigns can be launched within the following six months and can be connected to the ongoing marketing campaigns about rebuilding the city.

Temporary bike trials such as the already existing e-bike or foldable bike projects can be upscaled. They have shown success in Gothenburg and other cities. Larger projects can be immediately started and continuously be connected to large construction works in the city or with the establishment of the Västlänken project to provide a last-mile solution for those commuting to the city by train.

Secure parking is a way to counteract theft as well as securing the cycling related equipment from wear due to weather conditions. Furthermore, it is closely connected

to a successful rise of new technological solutions such as the e-bike or cargo-bike. The provided parking solutions at residential areas are already perceived sufficient by the end-users. However, parking needs to be supplied at transportation hubs to ensure a smooth connection to and from public transportation (PT), e.g. the central station, Saltholmen and Stenpiren ferry terminals or future Västlänken stations. Secure parking also needs to be provided at major business areas to ensure employees to park their bike safely while at work. The Västlänken project, in which major construction work is being undertaken, can be utilised to provide secure parking spaces at the transportation hubs to come.

Prioritising cyclists in construction projects during the major development phase of Gothenburg is an opportunity to use when planning to increase cycling. If the focus during construction lies on finishing the cycling infrastructure first and is prioritised in terms of space provided it can help to lower the entry-level threshold for non-cyclists. Additionally, the planned construction activities can be utilised to combine them with an extension of the cycling infrastructure. Examples for these can be to extend the coming cable-car solution over the river for the use of cycles as well or use the excavation works in connection with the Västlänken project to build underground bike-parking. The cable-car is planned to be in operation by 2021, the Västlänken project is set to be completed by 2026.

Seamless integration with public transportation (PT) is especially important to reduce the long-distance journeys done by car. In order to achieve a seamless integration, three areas need to be focused on: Expansion of the bike-sharing solution to and from the transportation hubs, secure parking solutions at the transportation hubs, and ensuring in the long-term that cycles can be taken on PT. The Västlänken project is once more a development that could be utilised for a better integration of cycling and PT.

An **expansion of the bike-sharing system** is necessary so that this system is not only used to replace short journeys, that otherwise would have been done on foot, but to enable for longer journeys or in connection with the use of PT. Two solutions within this field need to be investigated: A station-less free-floating solution, and an e-bike solution. The current bike-sharing system operation contract ends in 2020, which means that an upscaled solution can be implemented with the new contract by 2020.

Youth programmes are another way to increase cycling. As young people are not yet locked-in to their MoT, they are easier to motivate and some of them might continue cycling in the future, if it is perceived positively. Two proposed target groups for such programmes are young immigrants and students - both have a limited budget available for mobility and represent a large number of people in the Gothenburg region. This also has a positive impact on the integration of society by empowering people who are currently unable or discouraged to cycle. Youth programmes can be established using several concrete actions such as establishing bike kitchens, teaching cycling, and setting up cycle pool stations. All of these actions should be done specifically close to the housing and educational arrangements of the target groups. These actions could be established within the next three years.

11.4 Major focus points

Three areas of focus were identified during the execution of this thesis. They include communication of the positive effects of cycling, lowering the entry-threshold for non-cyclists, and improving the convenience for those who are cycling (see figure 11.1).

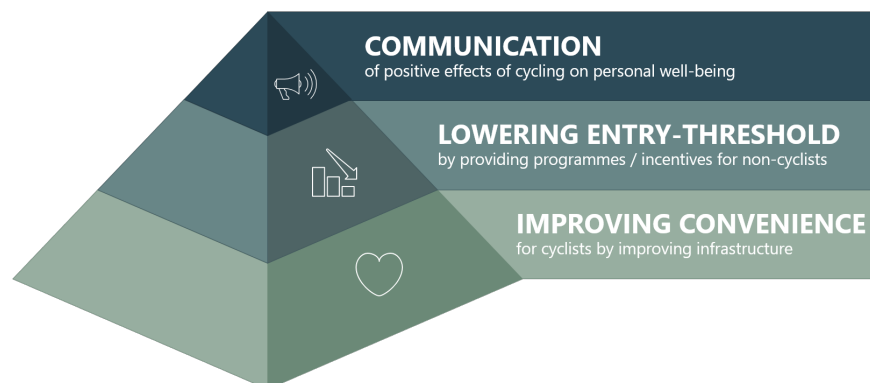


Figure 11.1 : Areas of focus to support a transition towards more cycling

To bridge the knowledge gap and empower more people, **communication** with the public is crucial to present the proven positive impacts of cycling regarding well-being, economical, societal and environmental aspects. Most importantly the improvements on well-being are to be communicated, showing that a transition towards cycling is not only beneficial to the society as a whole, but especially to the individuals. Communication requires some funding and can be done via marketing campaigns, on social media or involving public figures.

Lowering the entry-threshold for non-cyclists to introduce them to this mode of transportation (MoT) is another area to focus on. If the modal share of cycling shall increase, non-cyclists have to be convinced to change to this MoT. This can be done by providing non-profit cycling lessons to teach basic skills in cycling itself, but also by teaching how to fix simple bike failures. Furthermore, the threshold can be lowered by making bikes more available. This can be done in a shared manner by providing easily accessible bike pools in the city or through individual ownership but in a cheap and circular approach by setting up "bike-kitchens" where people can repair and access bikes, that were previously disowned and left in public spaces. Providing try-a-bike programmes has also proven to be very effective in increasing the amount of cyclists, as stated in the expert interviews. Within these programmes, local authorities provided "try-a-bike" programmes where electric or foldable bikes for free for a limited amount of time, giving the opportunity to try cycling as a MoT and experience the advantages themselves.

Finally, those who are cycling need to be kept satisfied by **improving the convenience** of this MoT. The current situation of infrastructure should be maintained and further developed. The main focus, should be the clear separation of bike lanes from non-active mobility modes and to empower people who cycle by giving them clear priority via cycling infrastructure. The detours that cyclists have to take should be identified and reduced to create an easier flow through the city. Cycling infrastructure should be prioritised during the road construction periods to divert the urban population more smoothly towards cycling. Seamless integration with public transportation (PT) should be established by creating secure bike parking areas at major transportation hubs and issuing combined passes for PT and bike sharing services.

11.5 Recommendations for further studies

In order to proceed with improving the quality of mobility for masses, the research for indicators of social and environmental benefits of cycling need to be further investigated. Furthermore, the benefits of lowering the overall speed for road traffic -as this was an ongoing process in Gothenburg by the time this research was conducted (Göteborgs-Posten 2017)- has to be assessed. The impacts of driving an electric vehicle (EV) versus riding a bike can be further examined in a comparative study.

Moreover, the possible ways, as well as the costs and benefits of a seamless integration of public transportation (PT) and cycling needs to be assessed, however not only limited to economic dimensions. Last but not least, the proposed youth programmes needs further effort to put into effect. To scientifically report the effects of it, it can be accompanied by another study.





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APPENDICES

APPENDIX A : Travel statistics from RVU Sverige

APPENDIX B : Cykelprogram för en nära storstad

APPENDIX C : Private bikesharing solutions provider interview





APPENDIX A - Travel statistics from RVU Sverige

Table A.1 : Data depending on mode of transportation in Sweden, linked to figure 10.1

Speed per MoT	foot	bike	public transportation	car and taxi	other modes combined
count of journeys:	13,235	3,336	5,333	19,423	141
km travelled:	45,754	23,866	133,313	583,432	1,887
average speed [km/h]:	4.67	11.62	20.85	35.81	22.09
median speed [km/h]:	4.19	12.00	17.55	33.10	20.04

Table A.2 : Comparison of median distance travelled in Gothenburg, depending on mode of transportation (linked to figure 10.3)

distance per MoT	foot	bike	public tran	car and taxi	other modes combined
count of journeys:	5,738.00	768.00	2,011.00	4,722.00	29.50
km travelled:	14,924.75	6,578.72	42,489.13	151,569.54	566.37
average distance per journey [km]:	2.60	8.57	21.13	32.10	10.28
median distance per journey [km]:	1.60	6.00	16.00	25.10	5.75

Table A.3 : Comparison of median speed depending on mode of transportation including multi-modal journeys. Sweden (linked to figure 10.8)

Speed per MoT	foot alone	bike	PT alone	foot + PT	car&taxi alone	foot + car&taxi	other modes combined
count of journeys:	7,587	3,336	4,046	1,283	15,541	3,846	141
km travelled:	26,925	23,866	106,302	30,529	482,157	110,908	1,887
average speed [km/h]:	4.54	11.62	21.76	13.48	36.57	19.52	22.09
median speed [km/h]:	4.00	12.00	18.60	11.05	34.29	16.29	20.04

Table A.4 : Modal shares of MoT in the Västra Götalandsregionen for daily journeys up to 100km. Västra Götalandsregionen (linked to figure 10.4)

modal share up to 100km travelled	foot	bike	public transportation	car and taxi	other modes combined
count of journeys:	8,940.00	1,228.00	2,514.00	8,446.00	242.00
km travelled:	23,496.61	9,148.66	57,920.68	268,488.05	3,430.49
average distance per journey [km]:	2.63	7.45	23.04	31.79	14.18
median distance per journey [km]:	1.60	5.00	17.00	24.00	8.00

Table A.5 : Modal share up to a distance travelled of 5 km. Västra Götalandsregionen(linked to figure 10.5)

modal share up to 5km travelled	foot	bike	public transportation	car and taxi	other modes combined
count of journeys:	7,560.00	660.00	351.00	970.00	22.00
km travelled:	12,094.30	1,770.53	1,134.51	3,043.66	53.87
average distance per journey [km]:	1.60	2.68	3.23	3.14	2.39
median distance per journey [km]:	1.08	2.50	3.00	3.30	2.50

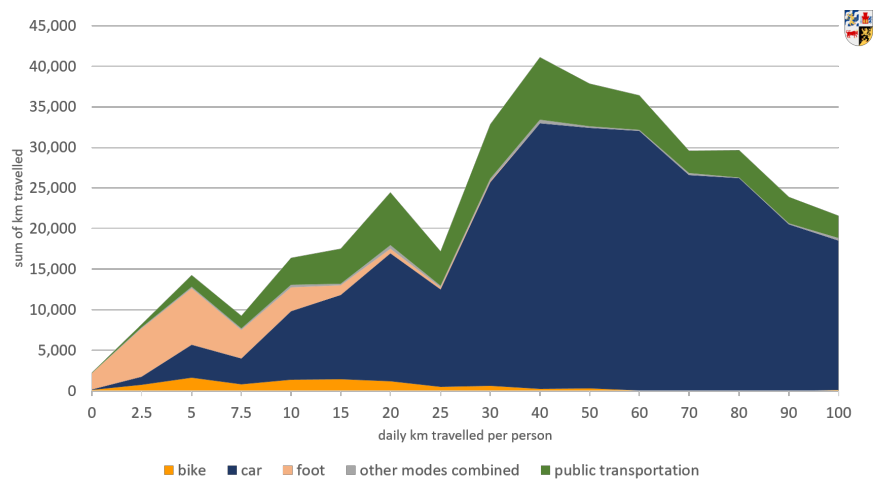


Figure A.1 : Stacked modal share over distance travelled to display the overall sum of km travelled

Table A.6 : Modal share over distance travelled. Västra Götalandsregionen (linked to figure 10.10)

Sum of Distance traveled	Column Labels					
Row Labels	bike	car	foot	other modes combined	public transportation	Grand Total
0	108	86	1,986	23	26	2,229
2.5	745	1,001	5,958	96	394	8,194
5	1,607	4,061	6,942	208	1,414	14,232
7.5	787	3,186	3,552	189	1,533	9,246
10	1,402	8,393	2,979	286	3,344	16,404
15	1,416	10,388	1,177	219	4,313	17,513
20	1,207	15,765	556	401	6,539	24,469
25	480	12,059	194	244	4,210	17,187
30	608	25,093	153	280	6,723	32,856
40	269	32,702		429	7,736	41,136
50	290	32,090		247	5,248	37,875
60	60	31,986		124	4,226	36,396
70		26,619		212	2,784	29,616
80		75	26,119	83	3,354	29,631
90			20,533	90	3,304	23,927
100		95	18,407	300	2,773	21,575
Grand Total	9,149	268,488	23,497	3,430	57,921	362,484

APPENDIX B - Cykelprogram för en nära storstad

The cycling strategy defines four areas of actions that will be used to fulfil the goals in the Gothenburg case:

- Infrastructure
- Operation and maintenance
- Support and Services
- Communication

Within each area more detailed goals are set. They are described in the following:

Infrastructure contains the most detailed descriptions and goals of the four areas. Three functional requirements are defined within infrastructure, namely the cycle network, parking for cycles, and cycling in the construction phase. These functional requirements are used for four planning principles, namely routes, crossings, parking for cycles, and cycling in the construction phase. The three functional requirements and four planning principles are combined in a technical handbook that describes the detailed requirements and processes in order to fulfil proper planning for the cycling infrastructure. The strategy further focuses on giving detailed descriptions of the cycle network that is divided into three different types of routes (commuting network, overall network, local network. Bike parkings are also described in further detail dividing into different requirements for three different purposes (short-term parking, long-term parking, and secure night parking). When discussing cycling in the construction phase, four major requirements are listed being providing good orientation, safety and security, sufficient width of the lane, and good comfort. There is also a dedicated section about improving the cycling infrastructure for children in the age of ten to twelve years. In it the goal is set to improve the infrastructure especially on the ways to and from school in a way that these children can cycle there on their own. The following activities are planned within the topic of infrastructure:

- Formulation of detailed technical solution that will be documented in the technical handbook.
- Charting and functional analysis of the existing cycling infrastructure.
- Determination of a development plan for the cycling network.
- A plan for how the traffic signals can be adjusted for the needs of cyclists.
- Development of guidelines for the placement of cycling signs.
- Development of a lighting plan for the cycling network.
- Setting of specifications for the construction of cycle paths.
- A detailed study about possible conflicts of interest between the development of the infrastructure for cycles and trams respectively.
- Development of a cycle-parking plan

- Multi-disciplinary cooperation to ensure that cycling is regarded a proper MoT during the construction phase
- Development of mobility solutions to ensure that cycling is a safe MoT during the construction phase
- Development of information package for businesses, contractors, and the traffic office to brief about the construction activities
- Development of new information channels to cyclists

Operation and maintenance can be summarised by setting five principles for ensuring proper Operation and maintenance (OM), being good winter service, regular sweeping and clearing of sand, even surfaces, maintenance of the signs and markings, and other maintenance of the cycle lanes. The planned activities for OM include:

- Establishment of a training programme for maintenance businesses.
- Investigation of a shared system to report defects and shortcomings.
- Refinement of guidelines for OM.
- Further development of quality assurance routines for OM.
- Obtainment of guidelines and goals for the OM of traffic signals.

Support and services are divided into three major requirements being the needs before the journey, the needs during a journey and the needs after a journey. The actions taken within this area are summarised by an app that has been developed to support cyclist with information and give them the possibility to report issues to the city, a website that has been developed in order to provide a travel planner, cycle pumps that are installed on several spots in the city, a bike-pool system in the inner city consisting of 60 stations with 800 bikes, and a cycling map that is offered in paper format. Especially the bike-pool system is planned to be extended in the following years extending the area covered to parts north of the river Göta Alv. The following activities are planned within this field:

- Further development of the existing cycle-pool system and assessment of possibilities to combine it with PT
- Further development online cycle-journey planning services
- Provision of open data for the market to stimulate the development of apps
- Further development of ways to report shortcomings in the cycling infrastructure
- Investigation of provision of service infrastructure such as charging of e-bikes, locking, and bike maintenance in combination with future cycle garages.
- Checking of needs for bike pumps and other service stations.
- Development of a cycle map that indicates different types of cycling routes such as nature and tourist routes.
- Collaboration for good cycling examples such as cargo-bike pools.

Communication is divided into four areas: Image-communication delivering the message that Gothenburg and cycling are truly connected, product-communication delivering the message that cycling is fast, easy and safe, behaviour-communication in order to get more people to choose the bike, and communication during the

construction phase in order to inform the cyclists about ongoing projects and how they can continue their journey with the least amount of interruptions. The goal is set to develop a common communication strategy. Within communication the following activities are planned:

- Obtain a general communication strategy.
- Obtain proposals for activities that support image communication.
- Obtain proposals how the product communication shall be developed.
- Develop stakeholder network with organisations, employers, cyclists and others.
- Further develop behavioural communication with the city of Gothenburg, other employers, schools, students, associations, and others.
- Spread the knowledge about Gothenburg as a cycling city on a national and international level via conferences, seminars, and articles.

The cycling strategy concludes with the importance of cycling being a part of the overall traffic system and that it should not be treated separately. Implementation principles are set as well which consist of prioritising central parts of the town and the commuting network, coordinated actions, planning for a good connection between cycling and PT, and planning for a good passability during the construction phase.



APPENDIX C - Private bikesharing solutions provider interview

During this interview they mentioned different types of payment plans, depending on the customers' demands; either monthly subscription or on-demand payment. They indicated that the demand for their services is high in Stockholm, however they do not have the capacity to meet this demand, thus keeping their customers limited to some businesses and real estate companies at the moment. The utilisation rates are significantly different between for employees at workplaces and tenants at residential areas, the second having a steady usage of cargo bikes. They stated that they offer services in Oslo and Stockholm where an important momentum to increase cycling is present, however the operation schemes are different. In Oslo, they had an easier actualisation of project due to Norwegian commercial laws. There, they have a free-floating service at a university campus with virtual stations that customers should return the bikes to, eventually. For future expansion, they stated that large campuses with too long walking distance between buildings have the greatest potential.

Their motivations to enter the market were: to do good for the environment and health, especially for housing companies, and to reduce the parking areas and replacing them with Mobility as a Service (MaaS). They stated that *"even if [they] used [the bikes] twice a month instead of taxi, it would still make them save money"* and *"there is no possibility to go faster to a meeting than riding an e-bike"* while mentioning the advantages of an e-bike. They added that statistical information is important to be kept, in order to keep track of the utilisation rate of each bike and to prove how much GHG is saved according to how many km were travelled.

The problems they encountered were: bureaucracy and public procurement law making it harder to enter the market, cycling clearly having a lower priority compared to other modes of transportation (MoT), bike infrastructure being unreliable and unsafe, the high threshold of switching from car or PT to cycling. Moreover, shared e-bike solutions have additional problems such as the need of plugging-in, bikes being less than fully charged, the investment costs and risks being substantially higher, the need for charging indoors during winter, due to lower temperature shortening the range.



CURRICULUM VITAE



BARKIN DALMAZ

Mejerigatan 2B LGH: 2108 412 76 Gothenburg, Sweden

Mobile: +49-1520-5215655

barkind@gmail.com

EDUCATION

Civil and Environmental Engineering MSc.

2016 – 2017 Chalmers University of Technology

Master's thesis with Challenge Lab: "Strategies for increasing urban cycling"

Application of Backcasting and Multilevel Design Model methodologies to improve urban mobility, Qualitative research methods, Stakeholder management, Urban logistics and traffic count.

Transportation Engineering MSc.

2013 – 2017 Istanbul Technical University

Intersection optimisation, Railroad design, Pavement management systems, Urban transportation planning, Road engineering, Sustainable transportation.

Environmental Engineering BSc.

2006 – 2012 Istanbul Technical University

Thesis on "Design project of Iznik Wastewater treatment plant"

Environmental Impact Assessment. Industrial Pollution Control: process profile and waste management, Urban hydrology, Water and Watershed management.

INTERNSHIP EXPERIENCE

Municipality of Guzelcamli, Turkey

July – August 2011

Solid Waste Management project in Aydin province, Kuşadası district. Route optimisation to reduce energy consumption during waste collection.

Istanbul Technical University

June – August 2008

Research Laboratory of Environmental Engineering. Reduction of endocrine disruptors. Published on: <http://dx.doi.org/10.1080/01919512.2010.493395>

SKILLS

Computing. MS Office, LaTeX, AutoCAD and Fortran programming language

Languages. Turkish and English: ILR5. Greek: ILR2, Swedish and German: ILR1

Driving. Although I prefer cycling, I have B and D1 class driving licence.

INTERESTS

Self-Leadership. As I have learned during master's education, sustainability management requires integrity and dedication. Leading a life according to my values.

Urban Cycling. During my thesis work, I have been greatly influenced by the movement, so I have switched to cycling, instead of public transportation. Improving my overall well-being.

Travelling and Sharing Economy. I have developed greatly by leaving my comfort-zone and travelling. Involved in Couchsurfing and local sharing communities.

REFERENCES

Asst. Prof. Jörgen Larsson. Chalmers University of Technology, Department of Space, Earth and Environment, Physical Res. Theory. +46-31-7723108 jorgen.larsson@chalmers.se

Prof. Ilhan Talinli, Emeritus Professor. Istanbul Technical University, Department of Environmental Engineering. talinli@itu.edu.tr