



## Cycling to Sustainability

The role of local public authorities in furthering the creation of sustainable Product-Service Systems to promote cycling for climate change mitigation.

Master's Thesis  
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**Abstract**

This master's thesis studies how local public authorities can support the creation of sustainable Product-Service Systems which promote cycling to reach climate change mitigation goals in the transport sector.

Transportation in general is one of the largest sources for greenhouse gas emissions in the European Union, making up about one fourth of all greenhouse gas emissions. This share is comparable in the Helsinki metropolitan area. The vast majority, about 90%, of those transport related emissions in Finland are caused by road traffic with private cars accounting for almost two thirds of those. In addition to the large amounts of greenhouse gases it produces, individual motorised traffic by cars also creates a scarcity of space in growing urban areas such as the Helsinki metropolitan area. To drastically reduce greenhouse gas emissions from transportation and to address the scarcity of space in urban areas a shift towards more sustainable modes of transportation is necessary which heavily builds on the use of public transportation as well as increasing walking and cycling.

In order for this shift to happen, new solutions need to be developed. Product-Service Systems (PSS) are seen in the literature as a viable solution to decouple economic growth from increased resource consumption. However, the literature also points out that PSS needs to be designed well to unlock the full sustainability potential. Despite the seemingly big benefits PSS could offer with regards to climate change mitigation, the literature found them to not be widely implemented yet. Among the reasons for that the necessary change in business models and the resulting need for investment as well as a lack of legislation mandating more sustainable solutions were named. The role of public institutions in furthering the creation of sustainable PSS solutions is mostly only discussed from as that of legislators or procuring entities.

The purpose of the thesis was therefore, to exploratively investigate whether public institutions, in particular local public authorities, could take other and more active roles in supporting the creation of sustainable PSS solutions especially with regard to those promoting cycling to enable reaching transport related climate change mitigation goals. For that six semi-structured interviews with four representatives from public institutions and two representatives from the local bike industry were conducted. The findings imply that local public authorities are already taking an active role in testing and promoting new sustainable business models through projects. Existing procurement regulations often limit supporting innovative solutions as competition might not exist. New models to, such as “market dialogue” need to be developed. Additionally the issue of financing the increased investment need for such sustainable PSS solutions needs to be addressed. This was found to be especially challenging with regard to solutions promoting cycling due the seasonality of the business.

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**Keywords** Product-Service Systems, Servitisation, Mobility, Transport, Cycling, Sustainability, Climate Change Mitigation, Public Authorities

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# Table of Contents

<b>1. INTRODUCTION .....</b>	<b>6</b>
1.1. <i>The Need for a Modal Shift in Mobility</i> .....	6
1.2. <i>Product-Service Systems to Mitigate Climate Change</i> .....	7
1.3. <i>Research Gap</i> .....	9
1.4. <i>Research Objectives</i> .....	10
1.4.1. <i>Research Questions</i> .....	10
1.5. <i>Context of the Study: Bikefy</i> .....	11
1.5.1. <i>Bikefy–A Brief Overview</i> .....	11
1.5.2. <i>Bikefy–My Personal Role</i> .....	13
1.6. <i>Structure of this Study</i> .....	13
<b>2. LITERATURE REVIEW .....</b>	<b>15</b>
2.1. <i>Product-Service Systems–An Overview</i> .....	15
2.1.1. <i>Definitions of PSS</i> .....	15
2.1.2. <i>Categorisation of PSS</i> .....	18
2.1.3. <i>Sustainability Potential of Product-Service Systems</i> .....	20
2.1.4. <i>Product-Service Systems in the Context of this Study</i> .....	22
2.2. <i>Why Product-Service Systems?</i> .....	23
2.2.1. <i>Environmental Benefits of Product-Service Systems</i> .....	23
2.2.2. <i>Social Benefits of Product-Service Systems</i> .....	24
2.2.3. <i>Other Benefits of Product-Service Systems</i> .....	25
2.2.4. <i>Climate Change Mitigation Policies from Global to Regional Level</i> .....	26
2.3. <i>Barriers for Implementing Product-Service Systems</i> .....	29
2.3.1. <i>Necessary Changes to Business Models</i> .....	29
2.3.2. <i>Increased Needs for Capital Investments</i> .....	31
2.3.3. <i>Different Requirements for Personnel</i> .....	31
2.3.4. <i>Customer Expectations</i> .....	32
2.3.5. <i>Regulatory Frameworks</i> .....	33
2.4. <i>Summary</i> .....	34

<b>3. METHODOLOGY .....</b>	<b>36</b>
3.1. <i>Research Design</i> .....	36
3.2. <i>Data Collection</i> .....	36
3.2.1. Interview Process .....	37
3.2.2. Sample .....	37
3.2.3. Interview Topics .....	39
3.3. <i>Data Analysis</i> .....	40
3.3.1. Transcription Process.....	40
3.3.2. Analysing Process.....	41
3.3.3. Coding Scheme.....	41
<b>4. FINDINGS .....</b>	<b>44</b>
4.1. <i>Barriers</i> .....	44
4.1.1. Differing Strategic Goals .....	44
4.1.2. Difficulties in Cooperating .....	47
4.1.3. Operating Modes Public vs. Private .....	49
4.1.4. Regulatory Frameworks .....	51
4.1.5. Need for Upfront Investment .....	52
4.1.6. Seasonality of Cycling .....	53
4.2. <i>Stimuli</i> .....	53
4.2.1. Sustainability Promoting Strategic Goals.....	54
4.2.2. Regulatory Frameworks .....	55
4.2.3. Projects and Trials.....	56
4.2.4. Investment.....	57
4.2.5. Measures to Promote Cycling.....	58
<b>5. DISCUSSION .....</b>	<b>61</b>
5.1. <i>Role of Public Authorities</i> .....	61
5.2. <i>Opportunities for Furthering the Creation of PSS</i> .....	62
5.3. <i>Challenges for Furthering the Creation of PSS</i> .....	66
5.4. <i>How to Further the Creation of PSS to Mitigate Climate Change by Promoting Cycling</i> .....	68

<b>6. CONCLUSION .....</b>	<b>71</b>
6.1. <i>Implications</i> .....	72
6.1.1. Theoretical Implications.....	72
6.1.2. Practical Implications .....	72
6.2. <i>Limitations</i> .....	74
6.2.1. Data .....	74
6.2.2. Language of the Interviews .....	75
6.2.3. My Own Involvement .....	75
6.3. <i>Future Research</i> .....	76
<b>7. BIBLIOGRAPHY .....</b>	<b>77</b>
<b>8. APPENDIX.....</b>	<b>84</b>
8.1. <i>Interview Guides</i> .....	84
8.1.1. Finnish Ministry of Transport and Communications.....	84
8.1.2. Helsinki Regional Transport Authority HSL .....	85
8.1.3. Helsinki Region Environmental Services Authority HSY .....	86
8.1.4. City of Vantaa.....	87
8.1.5. Independent Bike Shop .....	88
8.1.6. Bike Distributor .....	89
8.2. <i>Consent Form</i> .....	91
<b>Table 1: List of Interviewees .....</b>	<b>39</b>
<b>Table 2: Coding Scheme: Activities &amp; Goals .....</b>	<b>42</b>
<b>Table 3: Coding Scheme: Barriers &amp; Stimuli.....</b>	<b>43</b>

# 1. INTRODUCTION

## 1.1. The Need for a Modal Shift in Mobility

Climate change and rapidly growing urban populations pose increasing and complex challenges for cities around the world. The present reliance on the car as the dominant mode of transport further exacerbates the situation. It contributes to transport being one of the major sources for greenhouse gas emissions and leads to scarcity of valuable urban space by increasingly congesting roads and requiring large amounts of parking space. In light of these issues, it is becoming ever more acknowledged that a shift away from individual motorised transport by car, is becoming increasingly urgent in order to mitigate climate change, use land resources more effectively and create sustainable cities.

The European Commission for example is currently aiming at an 80%-95% decrease of greenhouse gas emissions overall by 2050 compared to the levels of 1990, with a milestone of 40% reductions by 2030 (EU, 2011a; da Graça Carvalho, 2012). For the transport sector alone that reflects in a target of 60% reductions of greenhouse gas emissions by 2050 compared to 1990 levels (EU, 2011b).

In Finland, transport emissions account for roughly one fifth of all greenhouse gas emissions. The vast majority of those, 90%, are being caused by road traffic. Out of those, passenger cars account for the largest amount at about 60% of the emissions caused by road traffic (Trafi, 2014). With regard to the Helsinki metropolitan area, the transportation sector made up for about 24% of carbon emissions in 2015, similar to the EU average of about one fourth of all greenhouse gas emissions, with private cars contributing a total of 14,4% of all emissions in the Helsinki metropolitan area (European Commission, no date; Helsinki Region Environmental Services Authority HSY, no date, pp. 25, 34).

In order to achieve the significant reductions in greenhouse gas emissions necessary to reach the aforementioned goals experts from various fields agree that much of the current urban car traffic will need to be substituted by more sustainable modes of transportation. These include walking, cycling and increased use of public transportation (EU, 2011b;

IPCC, 2018). These options would simultaneously reduce greenhouse gas emissions and decrease the need for urban space assigned to car traffic and car parking. Cycling is particularly interesting in that regard, as it combines getting to the desired destination quickly in an environmentally friendly way while simultaneously providing health benefits (Oja, Vuori and Paronen, 1998; Lindström, 2008) and requiring only a fraction of the space needed for car traffic or even buses (Helsinki City Planning Department, 2017).

Even though cycling has become a more popular option among residents of the Helsinki metropolitan area over the past years, the average percentage of cycling still remains relatively low, making up only 10% of all journeys in Helsinki based on data from 2016 (Helsinki City Planning Department, 2015, 2017). For comparison the modal share of cycling amongst all trips in Copenhagen was reported at 29% in 2016 (City of Copenhagen, 2017). This suggests that a large-scale transition to a more cycling-based urban mobility will likely not happen from the bottom-up alone, but needs to be supported and driven by public institutions. The ongoing infrastructure development programme in the Helsinki metropolitan area creating a network of core cycling routes, so-called Baanas, is laying the grounds for serving increasing amounts of cyclists. The (re-)introduction of the Helsinki city bikes in 2016 and their subsequent expansion as well as the two bike service points established at Narinkkatori and Herttoniemi are additional important steps for facilitating this transition. However, the question emerges how local public authorities, who are tasked with achieving the ambitious climate change mitigation goals set forth by the EU as well as national and local legislators, can accelerate the necessary shift towards more sustainable transport options, specifically cycling, to convert more car users quickly to reach Helsinki's ambitious goal of becoming carbon neutral by 2035 (City of Helsinki, 2018).

## 1.2. Product-Service Systems to Mitigate Climate Change

In order to address the increasingly visible impacts of climate change most of the global community has agreed to undertake efforts to limit the increase of the global average temperature to a maximum of 2°C, aiming at an increase of no more than 1,5°C compared to pre-industrial levels with the Paris Agreement (UN, 2015a). The European Union is aiming for a low carbon economy by 2050 (EU, 2011a) and has adopted an action plan for transitioning to a Circular Economy (EU, 2015) together promoting the consumption of

services rather than products to decouple economic growth from increased resource consumption. The Finnish Government aims at becoming a forerunner for the Circular Economy (Government of Finland, 2017) and has set the ambitious goal of eliminating transport related greenhouse gases by 2045 (Liikenne- ja viestintäministeriö, 2018). The roadmap outlined by Sitra (2016) serving as a basis for the Government's strategy outlines a strong emphasis on servitisation and highlighting so called Mobility as a Service (MaaS) solutions to achieve these goals. Helsinki itself aims at becoming carbon neutral by 2035 (City of Helsinki, 2018). In order to reach this goal related to reducing emissions from transportation, Helsinki is aiming at significantly increasing the share of cycling in the city.

To achieve these ambitious but highly important goals radical changes in both the economy and in people's lifestyles are necessary. This, in turn, requires fundamentally different business models. Businesses need to find ways how to make their operations more sustainable throughout the entire value chain in order to reach the environmental effects necessary. Decoupling economic growth from resource consumption is one way of doing so. This will require new businesses with service-based business models and old businesses to change their business models away from ever increasing product sales, a process called servitisation (Vandermerwe and Rada, 1988). Product-Service Systems (PSS) are seen as a potential pathway to achieve this as they focus heavily on offering services that provide access to products and their results without selling the products themselves. PSS thereby reduce the overall resources needed to serve the same or even higher amounts of users (Goedkoop *et al.*, 1999; Mont, 2002a; Heiskanen and Jalas, 2003; Tukker, 2004).

Despite all of this, economically successful PSS positively contributing to climate change mitigation are still far from being widely implemented. One potential reason for this is that developing such complex PSS might be very resource intensive for private businesses, especially with regard to the time it takes to build these systems and the profits businesses might fear to forgo when putting climate change mitigation goals first on their agenda (Mont, 2002b; Baines *et al.*, 2007; Tukker, 2015).



### 1.3. Research Gap

With those aforementioned ambitious goals for addressing climate change public institutions on all levels are facing huge challenges in coming up with solutions to facilitate reaching these climate change mitigation goals. Product-Service Systems are being discussed as a potential pathway of decoupling economic growth from resource consumption, thereby decreasing the carbon footprint of the economy, but the literature also outlines major barriers to widespread implementation of related business models as outlined in chapter two.

The role of public institutions does not appear to be widely discussed in this literature. When discussed at all, it usually remains limited to creating legislation and conducting public procurement that favours environmentally friendly services over the procurement of less sustainable services or products. However, public institutions act on a much larger spectrum and their roles are not limited to defining legal frameworks and procuring products and services. In the context of climate change mitigation global bodies of particular importance are for example the United Nations (UN) and its Intergovernmental Panel on Climate Change (IPCC). While those do not possess any binding legislative power, they do set important frameworks that are subsequently adopted and implemented by legislative bodies around the world. For Finland the relevant legislative powers are the European Commission setting European legal frameworks and the Finnish national parliament. However, there are a large variety of public authorities in charge of actually implementing the legislative frameworks on a local level such as local administrations as well as agencies. When developing sustainable transportation within the Helsinki metropolitan area these include for example the Helsinki Regional Transport Authority HSL and the Helsinki Region Environmental Services Authority HSY. It is especially those latter ones that do not seem to be emphasised much in existing PSS literature besides their role as procurers.

From that, the question emerges whether such local public authorities have the power to produce new innovative services for achieving climate change mitigation goals in the transport sector themselves or how they could contribute to creating new services together

with businesses, especially for increasing the modal share of cycling in the Helsinki metropolitan area.

## 1.4. Research Objectives

Based on the research gap outlined in section 1.3. the objective of this study is to provide insights into challenges and opportunities regarding the development of innovative Product-Service-Systems in order to reach climate change mitigation goals connected to transportation. The specific focus of this study lays on the role that local public authorities, who are tasked with reaching these goals, play and to which extent they can influence the creation of such PSS, specifically such aiming at increasing the modal share of cycling. The underlying assumption is that in opposition to individual private businesses public authorities often times face issues creating these new services due to legal restrictions or the way these authorities are set up.

By addressing this, the study will contribute valuable knowledge to the discourse on the process of developing Product-Service-Systems business models.

### 1.4.1. Research Questions

In order to fulfil the research objective stated above, the main research question to be addressed during this study is: How can public authorities further the creation of viable Product-Service-Systems to achieve climate change mitigation goals for transportation by promoting cycling?

In order to answer this question the following three subquestions will be addressed:

- a) What role do public authorities currently find themselves in with regard to furthering such innovations?
- b) Which opportunities exist for said authorities in furthering the creation of new innovative PSS in the context of public transportation with a focus on promoting cycling?

- c) Which challenges exist for said authorities in furthering the creation of new innovative PSS in the context of public transportation with a focus on promoting cycling?

## 1.5. Context of the Study: Bikefy

The context for this study is provided by the results of the “Creative Sustainability Capstone” project course at Aalto University’s School of Business. Said course is intended to be the students’ last course before writing the master’s thesis.<sup>[1]</sup> In this course I as the author of this study together with my team members Nicolas Dolce and Manuel Arias Barrantes in spring 2017 developed an innovative new mobility service for the Helsinki Region Environmental Services Authority (HSY) in cooperation with the Helsinki Regional Transport Authority (HSL). This service, called Bikefy, is an electric folding bikes as a service concept to solve the last mile issue of public transportation. The last mile issue describes the issue of having to get to and from a public transport stop or station from the point of origin or to the destination. This distance can be anything from just a few meters in dense city centres up to several kilometres in less densely populated areas.

Following the project course, all project partners including HSY, HSL and the City of Vantaa had expressed interest in moving forward with the idea though it was uncertain how exactly this could be accomplished. The three parties together subsequently joined forces and funded a one month trial period in September 2017 in Aviapolis, Vantaa, which was then planned, managed and documented by me. The former two team members from the course did not continue working on this concept.

The following subsection 1.5.1 will briefly outline the Bikefy concept to provide further background information for the context of this study. Subsection 1.5.2 further details my personal involvement with the concept following the study course.

### 1.5.1. Bikefy–A Brief Overview

In its essence, Bikefy is a monthly electric folding bike subscription. That means by paying a monthly fee a customer is provided with an electric folding bike and all necessary

maintenance/service. A high quality lock is always included, while extras such as helmets and bags can be added at an additional charge.

The goal of this service is to extend the regular monthly public transport ticket with a solution that addresses the last mile issue. Offering an electric folding bike as addition to public transportation could potentially alleviate this issue and provide a solution to bridge also longer distances to the closest public transport station or stop while simultaneously eliminating common problems when commuting (partly) by bike: safe bike parking, sweating, having to return to a certain station to pick up the bike or potentially only having the bike available at one end of the journey.<sup>[1]</sup> Providing bikes as a monthly subscription service instead of selling the bikes could lower the entry barrier of high upfront costs and the included maintenance service would eliminate the worry for technology failures or extended maintenance queuing times during the biking season.<sup>[2]</sup> Folding bikes can be taken on any means of transportation for free within the Helsinki metropolitan area and could thus be an ideal extension of the existing public transport network.

During the aforementioned trial in September 2017 six commuters working in the Aviapolis area in Vantaa, Finland, were given a public transport ticket for a month and both an electric and a non-electric folding bike for the duration of two weeks each, for free. Five out of the six commuters were otherwise mainly commuting by car. The goal of the trial was to test whether using an electric folding bike in combination with public transport could serve as a feasible alternative for car commuters. The results of the trial indicate that this indeed could be a promising way of replacing cars in commuting and thus reducing the carbon footprint of transportation (Schmidt, 2017).

Providing the utility of an otherwise quite expensive bike at the times when users want to use it most while taking care of all related maintenance creates a Product-Service System with electric folding bikes at its core. This PSS aims at offering an easy solution for taking climate action to enable a transition away from car-based commuting in order to significantly reduce the carbon footprint of transportation.

### 1.5.2. Bikefy–My Personal Role

Since finishing the CS capstone course, I have tried to evaluate whether and how the Bikefy concept can be turned into a viable business. As mentioned above, a trial has been carried out in September 2017<sup>1</sup>. Following further work a second trial in the Aviapolis area is in progress as part of the Perille Asti project hosted by the City of Vantaa<sup>2</sup> which which is still ongoing during the writing process of this study. Furthermore me and my colleague have participated in meetings and events of the Fiksu Assa project<sup>3</sup> as well as of the BSR electric project<sup>4</sup> co-run by HSY in the Helsinki metropolitan area to promote electric bikes. Thereby I remain personally tightly connected with the project and have been able to gather further experience in creating a Product-Service System of my own. Though this experience has not been academically documented throughout the whole process, it can serve as anecdotal evidence and provide further context for discussing the findings presented in chapter four in chapter five, Discussion.

### 1.6. Structure of this Study

Following this introductory chapter this study is made up of five chapters that are structured as follows: The second chapter, Literature Review, presents literature on Product-Service Systems. Following an overview of different definitions of PSS that concludes with a definition of PSS for the context of this study, the chapter provides an overview of benefits of PSS and outlines why they are a relevant concept in the context of climate change mitigation efforts. It continues presenting reasons that hinder the widespread adaptation of Product-Service Systems and concludes by formulating the hypothesis underlying this research. Chapter three, Methodology, presents the research

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<sup>1</sup> See <https://www.hsy.fi/fi/tietoa-hsy/uutishuone/2017/Sivut/Henkiloauto-vaihtui-Aviapoliksessa-HSLn-matkalippuun-ja-taittopyoraan.aspx> for further information.

<sup>2</sup> See <https://www.businessvantaa.fi/aviapoliksessa-kokeillaan-kahta-uutta-liikkumisen-palveluratkaisua-syksylla-2018/> for further information.

<sup>3</sup> See <https://www.asepanseutu.fi/fiksuassa/> for further information.

<sup>4</sup> BSR electric - Fostering e-mobility solutions in urban areas in the Baltic Sea Region: <https://projects.interreg-baltic.eu/projects/bsr-electric-121.html> and <https://www.bsr-electric.eu>

design of this study, provides an overview of the data collection methods and process and describes the data analysis that has been conducted. The subsequent chapter four, Findings, first presents the coding scheme that emerged from the data analysis process. It then continues by presenting first barriers and subsequently stimuli that were found to influence the endorsement of Product-Service Systems to promote cycling as a means of transportation within the Helsinki metropolitan area. The succeeding fifth chapter, Discussion, reviews the main findings in the context of the literature presented in chapter two, Literature Review, as well as in light of my own experience from continuing working with the Bikefy concept parallel to producing this work. It also considers the limitations of this study. The sixth and final chapter, Conclusion, outlines implications of this research and presents potential avenues for future research.

The interview guides used as a basis for this research can be found in the Appendix, as well as a sample of the consent form which was signed by each individual interviewee.

## 2. LITERATURE REVIEW

This chapter reviews the academic discourse on Product-Service Systems (PSS). Section one provides an overview on what Product-Service Systems are and how they are commonly categorised. It also outlines which role PSS could play for sustainability focused business operations. Section two outlines barriers to widespread implementation of PSS business models. Section three presents the definition for PSS underlying this study derived from the literature. Finally, section five outlines the hypothesis that forms the basis of this study.

### 2.1. Product-Service Systems–An Overview

This section provides an overview on the definitions of Product-Service System in subsection 2.1.2 and the commonly used categorisation of PSS in subsection 2.1.2. Subsection 2.1.3 outlines the sustainability potential of PSS. This section concludes with a definition of Product-Service Systems for the context of the study in subsection 2.1.4.

#### 2.1.1. Definitions of PSS

During the past decades, economies that had been heavily industrialised, have seen much of their industrial production move to Asia. As a result the service sector has grown and with that emerged the concept of the “*servitization of business*” (Vandermerwe and Rada, 1988).

A very distinct form of this move towards more service oriented business models is that of so-called Product-Service Systems. This field of research emerged at the end of the 1990s, beginning 2000s.

Commonly considered as the first definition of PSS (Baines *et al.*, 2007; Vezzoli *et al.*, 2014; Reim, Parida and Örtqvist, 2015; Annarelli, Battistella and Nonino, 2016) is the one by Goedkoop *et al.* (1999, p. 20):

*A PS system is described as a marketable set of products and services capable of jointly fulfilling a user's need. The product/service ratio can vary, either in terms of function fulfilment or economic value.*

Being the first, it is also one of the most commonly cited PSS definitions according to Annarelli, Battistella and Nonino (2016), who analysed a set of 224 Product-Service System related articles published between 1988 and 2016. They found the definition by Mont (2002a, p. 239) to be an equally frequently cited one and also the first to specifically link the concept of Product-Service Systems to sustainability:

*Thus, a PSS should be defined as a system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models.*

In the same year the UNEP (2002) defined PSS as follows without specifically highlighting any link to environmental benefits:

*A Product-Service System can be defined as the result of an innovation strategy, shifting the business focus from designing and selling physical products only, to selling a system of products and services which are jointly capable of fulfilling specific client demands.*

Baines et al. (2007) analysed 40 relevant articles and based on that offered a definition of PSS that again links the concept of PSS to environmental benefits which is also frequently referred to in succeeding literature on the topic:

*A PSS is an integrated product and service offering that delivers value in use. A PSS offers the opportunity to decouple economic success from material consumption and hence reduce the environmental impact of economic activity.*

Tukker (2004), who together with Mont appears to be one of the most notable authors in the field presented another quite important definition of Product-Service Systems which notably does not include any mention of sustainability per se:

*A product–service system (PSS) can be defined as consisting of ‘tangible products and intangible services designed and combined so that they jointly are capable of fulfilling specific customer needs’.*



The LeNS project in contrast proposed two slightly different definitions, one for eco-efficient Product-Service Systems and a second one for sustainable Product-Service Systems:

An eco-efficient PSS is *“an offer model providing an integrated mix of products and services that are together able to fulfil a particular customer demand (to deliver a ‘unit of satisfaction’) based on innovative interactions between the stakeholders of the value production system (satisfaction system), where the economic and competitive interest of the providers continuously seeks environmentally beneficial new solutions.”* (Vezzoli *et al.*, 2014, p. 31)

Compared to that they extend the definition of a sustainable PSS slightly to extend to *“[...] both environmentally and socio-ethically beneficial new solutions.”* (Vezzoli *et al.*, 2014, p. 48)

Annarelli, Battistella and Nonino (2016, p. 1017) also offer their own definition as a result of their aforementioned analysis and again link the concept of PSS directly to not only environmental but also social sustainability:

*PSS is a business model focused toward the provision of a marketable set of products and services, designed to be economically, socially and environmentally sustainable, with the final aim of fulfilling customer’s needs.*

Reim, Parida and Örtqvist (2015, p. 73) do not provide their own definition of Product-Service Systems but mention sustainability as one of the five important tactics when developing and implementing a PSS business model outlining, that “the importance of capturing the full environmental and social value is combined in the sustainability tactics”.

Based on the different definitions presented above it can be concluded that one unifying aspect among all of them is the focus on fulfilling a customer’s need by providing an integrated offering of products and services. The core economic activity within a Product-Service System is thus importantly not to merely sell a product to a customer and derive economic growth by selling more products to more customers. Instead, the goal is to offer a combination of products and services that lead to a more long-term oriented relationship between the provider and the customer. The definitions vary in directly linking PSS to environmental benefits, but especially the two extensive literature reviews by Baines *et al.* (2007) and Annarelli, Battistella and Nonino (2016) as well as Mont (2002a) and Vezzoli *et*

*al.* (2014) clearly establish a connection. It is also important to note that Mont (2002a) as well as Vezzoli *et al.* (2014) outline the importance of networks of stakeholders involved in providing a PSS, an aspect that is also emphasised by Tukker and Tischner (2006).

Subsection 2.1.2 takes a deeper look into Product-Service Systems' potential regarding environmental and social sustainability following a brief overview of the categorisation of different types of Product-Service Systems in the following subsection 2.1.2.

### 2.1.2. Categorisation of PSS

The literature describes Product-Service Systems differing in the extent to which they are rather product based or rather service-based. With regard to this differentiation criterium, PSS have commonly been categorised into three main types (UNEP, 2002; Tukker, 2004; Vezzoli *et al.*, 2014):

1. Product-oriented PSS,
2. Use-oriented PSS,
3. Result-oriented PSS.

These three main categories have also been outlined as the most significant PSS business model types by Reim, Parida and Örtqvist (2015) in their thorough literature review focussing on PSS business models.

Tukker (2004, p. 248) goes much further with his differentiation and outlines a total of eight models, which fall into these three main categories. However, as these subcategories do not seem to play a major role in other literature they are not considered in more detail for the purpose of this study either. An important aspect to note though is that with the service component continuously increasing from product-oriented to result-oriented Product-Service System the PSS become more complex in their configuration.

#### Product-oriented Product-Service Systems

In this first category, the most dominant activity of the provider is still to sell products. In addition to that, extra services are offered, but remain largely optional. These services might for example be maintenance contracts, providing consumables, offering training and

advice or even a financing scheme (which leads to the customer assuming full ownership) for the product itself (Tukker, 2004). It could also be take-back options for the product that are agreed upon when buying the product (UNEP, 2002). In this case, the customer buys the product from the provider and becomes the owner. If potentially life-cycle prolonging services have not been bought by the customer, it is their sole responsibility to take care of the product responsibly at the end of its life. In the realm of mobility an example would be the acquisition of a car. The customer buys a specific car and might opt to also buy a maintenance contract which entitles them to a certain amount of service per year.

### Use-oriented Product-Service Systems

In used-oriented Product-Service Systems the product itself still plays a fundamental role in fulfilling the customers' needs, but contrary to the product-oriented type of PSS it does not change ownership. The product remains the property of the provider, who makes it available to the customer for its intended use. This enables for example sharing a given product between multiple customers. Relating to the car example from above, one example of a use-oriented PSS is car-sharing. In this case a service provider such as DriveNow (BMW) or Car2Go (Daimler) remains the owner of the cars which they provide to individual customers' uses. The amount of products needed to fulfill a high number of customers' needs can be reduced as the products' use is decoupled from its possession by the user. As the provider remains the owner of the product at all times and is responsible for its proper functioning, there is an economic incentive to extend the life-cycle of a given product.

### Result-oriented Product-Service Systems

The third type of Product-Service Systems is result-oriented and does therefore not depend or rely on any predefined product. Instead the provider and the customer agree on a result that needs to be accomplished and the provider is then free to choose the best means. Relating that to the previous mobility examples involving cars the provider and customer would now not agree on there necessarily being any cars involved, but instead on the result. That could be transporting the customer from A to B at a given time at a predefined level

of comfort. Whether the provider chooses cars, bikes or any other means of transportation remains at their discretion, as long as the contractually agreed upon customer need is fulfilled properly. Tukker (2004) points out that while this type offers the largest amount of flexibility to the provider and thus provides the highest potential for eco-efficiency innovation it is also the most complex to contractually determine what the customers' needs are and when they are fulfilled.

### 2.1.3. Sustainability Potential of Product-Service Systems

While Goedkoop *et al.* (1999) did not explicitly mention a sustainability focus in their definition they do link the concept of Product-Service Systems to sustainability stating for example, *“that the service-based strategy could be a powerful concept towards sustainability.”* As mentioned in subsection 2.1.1, one of the most commonly cited definitions stating a very explicit goal of reaching (environmental) sustainability was introduced by Mont (2002a). Subsequently Baines *et al.* (2007), Vezzoli *et al.* (2014) and Annarelli, Battistella and Nonino (2016) also highlighted sustainability aspects with both Vezzoli *et al.* (2014) and Annarelli, Battistella and Nonino (2016) going beyond environmental sustainability to include social sustainability aspects as well.

However, Tukker (2004), Tukker and Tischner (2006) and Tukker (2015) are very cautious concerning positive sustainability implications of PSS. Tukker and Tischner (2006) argue that each of the three main categories of PSS offer very different potentials of reaching increased environmental sustainability. According to them, the most significant possibilities connected to environmental sustainability improvements can be achieved in the result-oriented category. With its sole focus on the outcome, the service provider is free to provide the service by whichever means possible. This should theoretically incentivise a decrease in resource use on behalf of the service provider while simultaneously increasing the will to innovate to further increase efficiency and effectiveness. Tukker and Tischner (2006) and Tukker (2015) emphasise that sustainability benefits are by no means inherent to PSS by definition but rather have to be specifically taken into consideration when designing a PSS. This has also been found to be true by Heiskanen and Jalas (2003) and Halme *et al.* (2006). Heiskanen and Jalas (2003) also point out that if products are rented out in use-oriented PSS by companies other than the manufacturer, which is usually the

case, these products are likely not specifically designed for rental purposes and thus not necessarily designed for durability, repair and upgrading. They argue that the economic incentive for doing so would only come into effect if the manufacturer was also operating the rental business. However, the importance of networks and increased stakeholder involvement highlighted by other authors (Mont, 2002a; Baines *et al.*, 2007; Vezzoli *et al.*, 2014; Annarelli, Battistella and Nonino, 2016) would alleviate this issue if the PSS provider and the product manufacturer cooperate closely and co-design the required products.

Specifically designing the products for durability and upgradability would also alleviate potential negative environmental impacts stemming from less careful usage of products in rental schemes (UNEP, 2002; Tukker, 2015). There is also an inherent danger that PSS can have adverse effects such as making car usage accessible to people who did not previously own or use a car (Heiskanen and Jalas, 2003).

In conclusion it can be said that PSS can indeed unlock great potential in achieving sustainability goals but only if they are designed well and special attention is paid to the products being used. If the PSS provider is not simultaneously the product manufacturer a very tight cooperation in order to assure product durability and upgradeability is necessary. With regard to the Bikefy concept, potential sustainability related improvements over existing solutions can be realised in at least three perspectives. Firstly, of course, the potential of replacing car usage in commuting by increasing the attractiveness of existing public transport options through solving the last mile issue by covering it with an electric folding bike. This would reduce greenhouse gas emissions from commuting and free up space that is currently dedicated to car traffic and parking. Secondly, resource usage could be minimised through high quality service and maintenance, reducing the wear and tear of bikes and thereby extending the product lifetime. Thirdly, on the social dimension, employing the necessary staff to keep the bikes in good condition would create jobs, as the bikes would likely need to be serviced more often than individually owned bikes. In the long run, further improvements could be made by either increasing the depth of cooperation with the bike manufacturer, or extending business operations to also producing own bikes which are custom build specifically for extended lifetime and ease of repairability and upgradeability.

#### 2.1.4. Product-Service Systems in the Context of this Study

For the purpose of this study definition of a PSS as an “integrated product and service offering” by Baines *et al.* (2007) is adopted as a starting point. Though Tukker and Tischner (2006) and Tukker (2015) emphasise that Product-Service Systems do not necessarily need to improve on the status-quo by addressing questions of environmental sustainability, this aspect is seen as a crucial characteristic of PSS in the context of this study. It thus follows Mont (2002a), Baines *et al.* (2007), Vezzoli *et al.* (2014) and Reim, Parida and Örtqvist (2015), amongst others, in their emphasising of a potential for offering environmental benefits when compared to non PSS solutions. Additionally the goal of increasing social sustainability as highlighted in the definition by Vezzoli *et al.* (2014) is deemed an important characteristic.

In the context of public transport in general and the Bikefy concept in particular the third respectively second main category of PSS outlined above are of particular relevance. Public transport and mobility in general can be seen as a result oriented PSS in which the focus is on the result of getting from points A to B. Whether that is accomplished by bus, tram or other means of transport might not matter too much to a potential customer as long as their respective needs are fulfilled. The use-oriented PSS business model is especially relevant to the Bikefy concept, as the product in question, bikes, is predefined as the product to achieve greater environmental sustainability with in the context of (public) transportation.

Though commonly outlined as first category of PSS, the product-oriented PSS is not included in the PSS definition for the context of this study, as the main focus in that type remains on the product and thus increasing individual unit sales. The lack of a strong link between product(s) and service(s) in this type negatively impacts the potential for environmental or social benefits.

As a conclusion, Product-Service Systems in the context of this study are defined as follows, based mainly on the definitions of Mont (2002a), Baines *et al.* (2007) and Vezzoli *et al.* (2014):

*A Product-Service System is a tightly integrated offering of services and products jointly produced by a network of actors to address a specific customer need while providing environmental and social benefits when compared to a product-centred solution. Going forward, unless explicitly mentioned, referring to PSS in this study does therefore not include product oriented PSS in which the ownership of a given product is transferred to the customer.*

## 2.2. Why Product-Service Systems?

This section provides an overview of the reasons why Product-Service Systems are a relevant concept in the context of climate change mitigation. Subsection 2.2.1 outlines the environmental benefits. Subsection 2.2.2 provides an overview of potential social benefits of PSS. Subsection 2.2.3 gives a brief overview of other potential benefits of PSS and subsection 2.2.4 provides an overview of relevant policies which provide a call to action for implementing sustainable Product-Service Systems.

### 2.2.1. Environmental Benefits of Product-Service Systems

The previous section outlined the definitions of Product-Service Systems and found that many of them indeed relate the concept of PSS to a decreased environmental impact. The major driver behind this potential positive effect on the environment is the decoupling from economic activity and environmental impact (Baines *et al.*, 2007). This enables businesses to increase their return per product unit, thus reducing the need for growing the sales of the products themselves which in turn results in less resources needed to produce them.

The fact that the ownership of the product remains with the PSS provider, at least in the use-oriented and result-oriented types of PSS, enables additional environmental benefits. Several authors indicate that this should incentivise the provider to extend the lifetime of a certain product by as much as possible in order to optimise the cost structure. As a result this will lead to minimised resource usage and thus result in further environmental benefits (Mont, 2002a; Heiskanen and Jalas, 2003; Tukker, 2004, 2015; Halme *et al.*, 2007; Baines *et al.*, 2007).

While the decoupling of resource use from financial return is generally seen as an enabler of environmental benefits they are by far not a given. Heiskanen and Jalas (2003) calculate

that services such as e.g. car sharing, drilling rentals or laundry services can indeed provide significant reductions of environmental impacts. However, they also point out that the achievable environmental benefits greatly depend on the actual configuration of the PSS in question and how it is operated, a notion that is further emphasised by Halme *et al.* (2006). Tukker and Tischner (2006) and Tukker (2015) highlight this as well and caution that especially in use-oriented PSS the environmental benefits are not always easily reached. For example there is a potential danger that leasing or rental services might lead to customer behaviour that eliminates environmental benefits through careless treatment of the leased/rented goods, potentially resulting in rebound effects (UNEP, 2002).

It can thus be concluded that Product-Service Systems indeed offer great potential for achieving environmental benefits over conventional product-based offerings, but it is crucial design and operate them properly in order to yield meaningful results. Especially the Product-Service Systems following the definition introduced in subsection 2.1.4 will provide significant environmental benefits, as they tightly integrate services and products, to achieve environmental benefits by leaving the product ownership with the PSS provider.

### 2.2.2. Social Benefits of Product-Service Systems

Tukker (2015) points out that products which are ideally suited for Product-Service Systems business models are usually expensive. Making the utility of such expensive products accessible through use- or result-oriented PSS can enable customers who were previously unable to afford such high quality products to get access. As they only need to pay for the actual use when it occurs, they do not face the burden of an overwhelmingly high upfront investment compared to lower end products. Mont, Dalhammar and Jacobsson (2006) detail this effect in the context of baby prams that are being rented to the customers for the rather short period which they are needed for compared to their potential lifetime. They point out that customers who were previously only able to afford second-hand prams are enabled to access the like-new prams that are offered through the baby pram rental model.

An additional social benefit can be seen in the job creation potential of PSS. Providing a well-functioning Product-Service System requires larger amounts of skilled staff than simply selling a product (Mont, 2002a). As most of these jobs cannot be outsourced to



low-cost manufacturing partners around the world, this has a direct positive social impact on economies that nowadays heavily rely on service sector jobs such as most Western European economies (Halme *et al.*, 2007; Baines *et al.*, 2007).

In conclusion it can be said that Product-Service Systems can provide social benefits regarding enabling access to higher quality products as well as regarding job creation potential.

### 2.2.3. Other Benefits of Product-Service Systems

Besides the environmental and social benefits presented above, the literature outlines further benefits of Product-Service Systems. While environmental and social benefits are mostly discussed from a societal perspective these further benefits are commonly being discussed from the perspective of a PSS provider such as manufacturers or other business entities involved in fulfilling the customers' needs that a given PSS aims at addressing.

Providing a PSS and thus tightening the interconnection of product(s) and service(s) enables businesses to innovate and better differentiate their offering from that of competitors. This is especially important in order to gain competitive advantages in industries which have reached a level of maturity that makes it increasingly hard to compete merely on product features (Vandermerwe and Rada, 1988; UNEP, 2002; Mont, 2002a, 2002b; Baines *et al.*, 2007; Tukker, 2015; Reim, Parida and Örtqvist, 2015; Annarelli, Battistella and Nonino, 2016).

By increasing the service component of an offering providers generally have to engage more extensively with their customers. Instead of relatively limited amounts of interactions in traditional after sales and support a PSS provider remains in contact with their customer throughout the whole duration of supplying the agreed upon service. This strengthens the relationship between the provider and the customers and can be beneficial for the PSS provider in terms of achieving customer lock-in and receiving more direct and larger amounts of customer feedback that help improve the PSS quality (Mont, 2002a; Tukker, 2004; Baines *et al.*, 2007).

Offering a Product-Service System and thereby decoupling financial success from strongly relying on economic growth by continuously increasing product sales year over year can

also provide strategic competitive advantages for businesses to comply with future environmental legislation. Such legislation appears to be inevitable in light of current climate change mitigation challenges and companies that employ PSS business models should be in a better position to address them as argued by Mont (2002a) and the UNEP (2002). As these policies are likely going to become a major driver for implementing PSS business models, the following subsection 2.2.4 will take a closer look at relevant frameworks at the European as well as the national Finnish level.

#### 2.2.4. Climate Change Mitigation Policies from Global to Regional Level

Recognising the impact of human made emissions efforts are being undertaken to develop policies that aim at limiting and subsequently eliminating carbon emissions to further sustainable development and pave the way to a carbon neutral economy.

In a global context the Paris Agreement (UN, 2015a), which entered into force on 4th November 2016, mandates limiting the raise of the global average temperature to “*well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1,5°C above pre-industrial levels*” and implementing policies to achieve that goal in order to alleviate the impacts of climate change. The recently published IPCC special report on the impacts of global warming of 1,5 °C insistently calls for “*rapid and far-reaching transitions*” across the board, including transportation, outlining walking and cycling as relevant mitigation actions for limiting global warming to 1,5°C (IPCC, 2018). Additionally, succeeding the eight Millennium Development Goals (MDGs), seventeen Sustainable Development Goals (SDGs) were formulated by the UN (2015b). Goals 11 and 13 call for actions to fight climate change in the context of making cities and other forms of human settlements sustainable. On their website<sup>5</sup> presenting the SDGs the UN specifically promotes cycling, walking and using public transportation as concrete actions for keeping cities’ air clean and thereby reaching goal 11.

These global, high level goals do not specifically argue for an increase of servitisation but set an agenda which calls for suitable measures to be implemented in the specific national

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<sup>5</sup> <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

and regional contexts. On the European level strategies for transitioning towards more sustainable economies which compliment these goals already exist, namely Europe 2020—A European strategy for smart, sustainable and inclusive growth (EU, 2010); the Roadmap for moving to a competitive low carbon economy in 2050 (EU, 2011a), the European action plan for the Circular Economy (EU, 2015) and the White Paper on transport (EU, 2011b). Together these provide a framework that outlines the EU wide targets of lowering overall carbon emissions by 80-95% and in the transport sector by 60% by 2050 in comparison to 1990 levels, a promotion of consuming services over products and the call for walking and cycling as integral parts of urban mobility instead of driving by car.

With regard to Finland it becomes more concrete on the national level, where the sitting Finnish Government has declared to become a forerunner in the Circular Economy and wants to redefine the legislation around transportation furthering the creation of so-called Mobility as a Service (MaaS) solutions to address climate change and enable mobility servitisation (Liikennevirasto, 2017; Government of Finland, 2018). Regarding the Circular Economy, the Finnish Innovation Fund Sitra was tasked with outlining a roadmap that covers different areas. Transport and logistics being one of the focus areas the roadmap calls for developing a *“more service-based transport system”*, that promotes *“alternative forms of transport to replace private cars, such as compatible door-to-door mobility services (MaaS), smart and easy-to-use public transport, and the development and spread of new services, walking, cycling, ridesharing and car sharing.”* (Sitra, 2016) This roadmap has been adopted by the Finnish Government in Action Plan for a Circular Economy (Government of Finland, 2017) to establish *“Finland as a platform for developing new product and service innovations”* with one of the priorities being regional mobility. The Finnish Government has also appointed a Transport Climate Policy working group from April to December 2018 with the goal of providing insights into how transport related greenhouse gas emissions in Finland could be eliminated by 2045. In their mid-term report they present three different paths—biofuels, technological transition (e.g. e-mobility) and services. While they preliminarily conclude that not one of them can reach the goal alone, the report outlines that the creation of new services can significantly contribute to reducing carbon emissions produced by transportation (Liikenne- ja viestintäministeriö, 2018).

On the local level, in the Helsinki metropolitan area, the City of Helsinki aims at reducing carbon dioxide emissions by 30% until 2020, compared to 1990 levels. Its air quality plan (Helsingin kaupungin ympäristökeskus, 2016) states that traffic is the reason for exceeding limits of nitrogen dioxide and subsequently 24 out of 48 measures to improve air quality address traffic. Besides addressing parking policies and the switch to alternative fuel sources the plan also calls for shifting traffic to walking, cycling and public transport. This goes hand in hand with the city's land use planning (Helsingin seudun yhteistyökokous, 2015), that emphasises the development of residential areas with a focus on walkability, cyclability and access to public transport, as well as the Helsinki Region Transport System Plan HLJ 2015 (HSL, 2015), which outlines measures such as vehicular pricing (congestion charges). Overall Helsinki aims at increasing the modal share of cycling to 15% by 2020 from 11% in 2013 and has therefore put in place a Cycling Promotion programme (Helsingin Kaupunkisuunnitteluvirasto, 2014) that strongly focuses on improving the infrastructure for cycling to create safe environments for everyday cycling but also highlights the importance of creating services around cycling such as maintenance and the provision of city bikes. On top of that in March 2018 Helsinki announced its plan to become carbon neutral by 2035 (City of Helsinki, 2018), which further emphasizes an increase in walking and cycling to reach a transport related emissions cut of 60% until 2035 compared to 2015 and the introduction of vehicular pricing. In order to monitor the progress of the state of cycling in the Helsinki metropolitan area, the City of Helsinki has started publishing biannual bicycle accounts (Helsinki City Planning Department, 2015, 2017) indicating that the improvements in bike infrastructure, such as the extension of the Baana network ("bike highways") and the improvements in winter maintenance of cycling lanes indeed lead to an increase of cycling.

In conclusion it can be said that national and local policies are increasingly addressing climate change mitigation goals and Finland in particular has ambitiously claimed to become a forerunner of the Circular Economy. Many cities, such as Helsinki, are even aiming to outpace European targets and are aiming to address transport emissions largely targeting an increased modal share of walking, cycling and public transport. While certain plans, such as the roadmap outlined by Sitra (2016) adopted by the Finnish Government (Government of Finland, 2017) do specifically highlight the creation of new services in

order to address this necessary shift in transportation there is not yet any particular legislation in place that either demands or significantly favours the creation of Product-Service System. However, as outlined above businesses would be particularly well prepared to address these existing strategies and policies if they were to implement well designed Product-Service System business models as argued for example by the UNEP (2002) and Mont (2002b).

## 2.3. Barriers for Implementing Product-Service Systems

As promising as Product-Service Systems may sound thus far, there appear to be quite significant barriers to their widespread implementation. In fact, the Journal of Cleaner Production made volume 97 of June 2015 a special volume dedicated to the question why ‘Sustainable Product-Service Systems’ have not been widely implemented yet.<sup>6</sup> This section provides an overview on the five seemingly most widely recognised ones: necessary changes to business models (subsection 2.3.1), increased needs for capital investments (subsection 2.3.2), requirements for differently skilled and larger amounts of personnel (subsection 2.3.3), customer expectations (subsection 2.3.4) and regulatory frameworks (subsection 2.3.5).

### 2.3.1. Necessary Changes to Business Models

Most of the literature discusses Product-Service Systems as a new strategic opportunity for already existing manufacturing or service businesses to decouple economic success from increased growth of product sales which always come at the price of a simultaneously increased growth in resource consumption. However, changing from a product sales centric strategy to one that is focused around the provision of services requires a major redesign of a company’s business model as the core value proposition changes (Mont, 2002a, 2002b; Baines *et al.*, 2009). As a result, one of the main barriers to implementing PSS business models is seen in the effort it takes to change the currently existing business model as it necessitates a significant restructuring of the company itself (Halme *et al.*, 2006;

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<sup>6</sup> Journal of Cleaner Production, Volume 97 (15 June 2015): <https://www.sciencedirect.com/journal/journal-of-cleaner-production/vol/97/>

Baines *et al.*, 2009; Tukker, 2015). This restructuring can only be accomplished if a company's top management is dedicated to making the change (Vandermerwe and Rada, 1988; Mont, 2002b). Furthermore it needs committed supporters within a company's workforce, which Mont (2002b) called "catalysts", as the "*reorientation of companies towards PSSs requires a fundamental shift in corporate culture*" (Mont, 2002a, p. 243).

This transformation to a service-based business model does not just demand significant internal changes within a given company, it also requires changes in a company's supply chain interactions and increased cooperation between the different actors in a network that contributes to the PSS (Mont, 2002a, 2002b; Tukker, 2004; Baines *et al.*, 2007). As a result increased capacities for stakeholder management might be needed to avoid acceptance issues of relevant stakeholders (Annarelli, Battistella and Nonino, 2016).

On top of that, a business model focusing on the provision of services considerably changes the cash flow as profits are not anymore generated rather short term by selling products, but instead in smaller increments over a prolonged period of time through leasing or rental models. This creates uncertainties about the restructuring of cash flows in existing businesses (Mont, 2002b; Mont, Dalhammar and Jacobsson, 2006) as it oftentimes contradicts the prevalent economic goals that are geared towards short term profit generation (Halme *et al.*, 2006).

It can be concluded that changing from a product sales oriented business model to a PSS business model dominated by providing services requires significant effort concerning restructuring an existing company and can only be achieved if the benefits outlined in section 2.2 are a driving factor for top management to initiate the transformation. Even then it needs to be met with support by at least some "catalysts" among a company's existing workforce to be successful in is thus certainly all but an easy task. Two other major challenges that go together with redesigning the business model towards a Product-Service System are the increased needs for capital investment and the differing requirements regarding personnel which will be outlined in the following two subsections. While the literature highlights the necessity and increased importance of a network of stakeholders to create a successful PSS, such a tight alliance will still require significant changes to the cooperating entities' operational processes. It could be easier to establish new companies

that do not have to significantly change internal structures, but this option and its potential benefits or downsides was not discussed in the literature presented above.

### 2.3.2. Increased Needs for Capital Investments

A Product-Service System changes the ownership structure from transferring ownership to the buyer of a product to leaving ownership of products required to produce the service with the PSS provider. As a result, there is another major change regarding the financials of a PSS provider besides the aforementioned changes in cash flow: an increased need for capital investment (Tukker, 2004, 2015; Halme *et al.*, 2007). This is especially true for PSS providers who are not traditional manufacturing companies as they first have to acquire the, usually quite cost intensive, products whose function they aim to provide as a service as exemplified for instance by Tukker (2004) with the case of car leasing companies. Besides the need for investing in the necessary products, additional investments are required to facilitate the transition towards a PSS business model to build up the necessary infrastructure and relationships with stakeholders to successfully provide quality services (Tukker, 2004, 2015; Halme *et al.*, 2007). Maintaining the ownership of a product also requires PSS providers to internalise use related and end-of-life related costs which were found to pose challenges for existing companies (Mont, 2002b; Baines *et al.*, 2007).

It can be concluded that establishing a PSS is a very capital intensive endeavour for the provider and though in reducing the necessary upfront investment for a product and shifting it to smaller incremental payments for services clearly unlocks benefits for the potential customer as outlined in subsection 2.2. in order to achieve these providers need to find ways of financing the necessary investments on their end to generate profit over time.

### 2.3.3. Different Requirements for Personnel

The significant redesign that is required of a company's business model in order to establish a PSS outlined in subsection 2.3.1 subsequently demands changes in a company's personnel structure. In order to yield the benefits of increased customer feedback to further innovate and produce better offerings increased communication with the customers and across the entire supply chain are necessary. This not only "*extends the role of the*

*marketing division*” (Mont, 2002a, p. 242), it also requires different skillsets throughout the entire organisation to communicate this feedback to partners and implement it in the design of services which most product oriented companies often lack (UNEP, 2002; Vezzoli *et al.*, 2014, 2015; Tukker, 2015; Annarelli, Battistella and Nonino, 2016). The aforementioned changes to a business’ cash flow and increased needs for investment require different knowledge regarding financing a company’s operations (UNEP, 2002).

In addition to significantly different managerial qualifications needed to successfully provide a PSS (Baines *et al.*, 2007; Vezzoli *et al.*, 2015) it also requires an increased number of maintenance staff to lengthen product lifecycles and ensure customer satisfaction (Mont, 2002b; Tukker, 2004; Baines *et al.*, 2007). This increased need for personnel directly translates into higher operating costs for labour intensive maintenance services especially if products are not specifically designed for the increased use in leasing or rental schemes and thus deters companies from transitioning towards PSS (Mont, 2002b; Heiskanen and Jalas, 2003; Mont, Dalhammar and Jacobsson, 2006).

In conclusion it can be said that successfully operating Product-Service Systems requires highly skilled management and maintenance personnel and in many cases also increased amounts of maintenance staff. While this is one key social benefit of PSS, as outlined in subsection 2.2.2, it is a barrier for companies to implement PSS business models as it requires significant amounts of resources for implementation.

#### 2.3.4. Customer Expectations

When offering a solution as a Product-Service System providers often seem to face a reality in which potential customers are not yet used to paying for a function of a product instead of for the product itself. This anticipated lack of customer acceptance poses an additional barrier for businesses to implement PSS solutions (Mont, 2002b; Halme *et al.*, 2006; Baines *et al.*, 2007; Tukker, 2015). Halme *et al.* (2006), Mont (2002b) and Tukker (2015) caution that the importance of ownership and the perceived increase of social status derived thereof can hinder adaptation of PSS offerings in B2C markets even though these would provide financial benefits to the customers. One major reason for that is that private customers often are not fully aware of the entire lifecycle cost of a product. In addition to some customer groups being unwilling to get use out of refurbished products instead of



buying new ones there are also some companies who do not want to be associated with second-hand products (Mont, 2002b).

While this potential lack of customer acceptance for a given PSS solution appears to be a significant challenge in B2C markets the situation is a lot different concerning B2B solutions. Here owning products not only appears to be less relevant but often even sought after in an attempt to outsource any secondary business activity (Vandermerwe and Rada, 1988; Halme *et al.*, 2007; Baines *et al.*, 2009; Tukker, 2015; Vezzoli *et al.*, 2015).

In conclusion it can be said that while B2C solutions exist, a PSS provider might find it easier to operate in the B2B market as businesses appear to be more ready and willing to pay for units of use or results than investing in products.

### 2.3.5. Regulatory Frameworks

As outlined above, in subsection 2.2.4, climate change mitigation policies not only favour but demand a decoupling of economic growth and resource consumption for which Product-Service Systems can be a very suitable tool. Such kind of policies that translate into national legislation not only seem to be a major driver for the creation of PSS solutions, but to some extent a necessity. Mont (2002b) illustrates that many PSS solutions implementing recycling or developing chemical management services have in fact been created as a result of legislative regulation. Goedkoop *et al.* (1999), Heiskanen and Jalas (2003), Halme *et al.* (2007), Baines *et al.* (2007) and Tukker (2015) also point out that it needs further legislation clearly favouring the provision of environmentally and socially beneficial service solutions in order for PSS business models to become more attractive alternatives for existing companies. One very influential legislative measure in this context could be taxation schemes favouring the consumption of services over buying new products. Another very important tool to stimulate the creation of Product-Service Systems is public procurement, specifically such public procurement that favours services over product based solutions and highlights the importance of environmental benefits (Vezzoli *et al.*, 2015). However, while public procurement can be a very meaningful tool to enforce sustainable solutions in a market where a variety of offers are already existing for a given problem, existing regulations can often not stimulate the creation of new sustainable PSS solutions. This is because of public procurement regulations demanding a variety of

competing offers. In the case of innovative new solutions there are usually no such competing offers available, which puts providers of innovative new solutions at a disadvantage of being unable to compete. As a result new models for procuring sustainable new solutions are necessary, which is why for example Temmes *et al.* (2014) call for the design of policies to enable market formation for innovations. As mentioned earlier, a key benefit for companies that implement PSS business models would be an improved strategic positioning regarding addressing existing, but especially also future environmental legislation (UNEP, 2002, p. 11). In the absence of such regulations, companies are still often unwilling to internalise risks and costs associated with improving environmental performance (Mont, 2002b).

It can thus be concluded that, regarding regulatory frameworks, not the existence of too tight regulations is limiting the widespread implementation of Product-Service Systems but rather the lack thereof.

## 2.4. Summary

Based on the literature presented above it appears clear that Product-Service Systems, when designed correctly, can provide significant environmental as well as social benefits. This makes PSS business models ideal solutions to address the pressing challenges of climate change mitigation. However, as outlined above the literature also clearly indicates barriers which hinder a widespread transition to PSS business models by existing companies. While companies that start out with PSS business models would not face the enormous challenges to transition from an existing product based business model towards a service dominated PSS business model, the challenge of high capital investment needs still remains. As a result there are public authorities on the one hand who are tasked with finding solutions to addressing climate change mitigation goals while existing businesses on the other hand cannot or do not want to quickly adopt to these goals. However, the role of public authorities is not extensively discussed in the PSS literature beyond suggesting a need for more environmentally focused legislation. The question arises whether public authorities that are not part of the legislative branch could contribute more to the creation of PSS besides enforcing sustainability oriented procurement guidelines. Based on that the underlying hypothesis of this study is that public authorities might need to find new ways

of supporting the creation of sustainable Product-Service Systems in order to address the challenges in reaching climate change mitigation goals. How can they do that, specifically, how can they support the creation of sustainable Product-Service Systems? That is the research objective of this study as outlined in section 1.3, to research how public authorities could support the creation of sustainable product service systems, specifically how they could support the creation of sustainable product service systems to facilitate a modal shift towards a more cycling based mobility.

## 3. METHODOLOGY

In this chapter the underlying methodology of this study will be presented. The first subsection outlines the research design in general. The second subsection presents the data collection process, detailing the interview process, the sample and providing a brief overview of the contents of the different interviews. The third subsection presents the data analysis focusing on the transcription process on the one hand and the subsequent analysing process on the other hand.

### 3.1. Research Design

Due to the rather explorative character of this study, it has been carried out as a qualitative single case study. The case framing this research is the development process for innovative and sustainable solutions to mitigate climate change. More specifically of that aiming at reaching emissions reductions goals in transportation by cycling. According to Eisenhardt (1989) a case study is a particularly well suited approach to understand the specifics that are prevalent in a certain case. Additionally, Yin (1981, p. 98) has pointed out, that case studies are particularly appropriate when the goal is to “examine a contemporary phenomenon in its real-life context”. Developing new solutions for reaching climate change mitigation goals in transportation is a very pressing contemporary phenomenon and this study aims at understanding how this process could potentially be improved.

### 3.2. Data Collection

The main data source for this study are interviews that provide the perspective of the relevant actors. Conducting interviews has helped significantly in overcoming shortcomings with regard to the author’s Finnish language proficiency which has limited access to prior research published e.g. by HSL and HSY.

The following subsections will outline the interview process as well as the sample and topics covered by the individual interviews.

### 3.2.1. Interview Process

All interviews were conducted as so-called semi-structured interviews during a one month period between 22nd May and 21st June 2017. Semi-structured interviews follow a somewhat predefined guide of set questions, but allow for follow-up questions or taking into consideration unforeseen issues that might arise during the interviews (Adams, 2015). The interview guides are published in the Appendix, section 8.1. The language of the interviews was English. All of them have been recorded and transcribed based on informed consent with the interviewees. Informed consent is a concept aiming at providing the informant sufficient information on what will be happening with the recorded data so that they can agree on how the interview transcripts may be used (Gläser and Laudel, 2009). For that the intentions to publish the anonymised interview transcripts and reasons for doing so were outlined before starting the interview. Written agreements of recording and transcribing the interviews, as well as the consent to publish them, were collected prior to starting each interview. The main intention behind the initial goal to publish the anonymised interview transcripts was to achieve greater trustworthiness Eriksson and Kovalainen (2008). Additionally I wanted to provide data for further research. Previous experience indicated that most people were generally positive to having their interview transcripts published. This was also the case here. All interviewees agreed to have the transcript published in anonymised form. However, Gläser and Laudel (2009) caution that it might not always be possible to fully inform informants about the consequences a published transcript, even though anonymised, might bring with it. Eventually it has been decided not to publish the anonymised interview transcripts in order to protect the interviewees due to the openness with which the answers were given.

### 3.2.2. Sample

All in all six interviews have been conducted. Four of them with representatives from the following four different public entities: the Finnish Ministry for Transport and Communications (LVM), the Helsinki Regional Transport Authority (HSL), the Helsinki Region Environmental Services Authority (HSL) and the City of Vantaa. The Finnish Ministry of Transport and Communications through its legislation is directly shaping the framework in which local authorities can develop new innovative mobility solutions and

has declared Mobility as a Service one of its key objectives which makes it a relevant source for this study. HSL is relevant to this study as the public authority responsible for planning and organising public transport in the Helsinki metropolitan area and adjacent municipalities. At the time of the interviews HSL was also working on defining its role as a Mobility as a Service operator. Its strategic goal is to increase the modal share of walking and cycling and in the summer of 2018, HSL has carried out the IdeaLab competition<sup>7</sup> with which it aims to further the creation of innovative mobility services. However, as the latter was not announced at the time the interview has been carried out, it has not been a subject thereof. HSL had joined the study project in which the Bikefy concept was developed during the course of the project and was thus closely connected to the background of this study. HSY is the public authority mainly responsible for providing waste management and water services as well as environmental information for the Helsinki metropolitan area. It is relevant for this study, as it is one of the public bodies mainly responsible for developing strategies to achieve the goals set by the Paris Climate Agreement and closely cooperates with HSL in doing so concerning transportation. HSY has also been the main project partner in the aforementioned study project. The City of Vantaa is relevant to this study as it has been the second initial partner of said study project and because it is actively aiming at supporting the creation of innovative new mobility services especially concerning developing the Aviapolis area. Together HSL, HSY and the City of Vantaa have not only been part of the study project resulting in the development of the Bikefy concept, but have also subsequently jointly funded a trial in the Aviapolis area. The trial was carried out after the interviews were conducted and thus not subject thereof.

The remaining two of the six interviews have been conducted with representatives from the bike industry: one independent bike shop owner and a regional manager of a large bicycle distributor to which several shops in the Helsinki metropolitan area belong. These two businesses have been chosen as one of them already cooperates with the public authorities of the City of Helsinki in providing cycling related services through its

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<sup>7</sup> See <https://www.hsl.fi/idealab> for further details.

subsidiaries and the other one has attempted to cooperate with HSL regarding promoting the combination of public transport and cycling but experienced difficulties in doing so.

Table 1 lists the interviewees and the abbreviations that will be used going forward when presenting the findings.

**Table 1: List of Interviewees**

Organisation	Abbreviation	Date of Interview
Finnish Ministry of Transport and Communications	LVM	22.05.2017
Helsinki Regional Transport Authority HSL	HSL	23.05.2017
Helsinki Region Environmental Services Authority HSY	HSY	24.05.2017
City of Vantaa	COV	24.05.2017
Independent Bike Shop	IBS	24.05.2017
Bike Distributor	BD	21.06.2017

With the exception of the bike distributor I have previously been in contact with all of the remaining five interview partners as a result of two different study projects on mobility issues, which has made it significantly easier to get interviews.

### 3.2.3. Interview Topics

Based on prior knowledge about most of the interviewees it was assumed that little to no previous awareness for the concept of Product-Service Systems would be prevalent, at least not under this specific term. As a consequence, the interviews did not mention this concept directly. Instead during the four interviews with the public authorities including the Finnish Ministry of Transport and Communications (LVM), the Helsinki Regional Transport Authority HSL, the Helsinki Region Environmental Services Authority HSY and the City of Vantaa the term services has been used. Those interviews focused on their approaches to support the creation of innovative new services. With regard to HSL, HSY and the City of Vantaa it was also discussed which possibilities exist for directly creating innovative new services by themselves. Additionally these four interviews discussed their roles concerning reaching climate change mitigation goals. During the two interviews with bike industry representatives a focus has been placed on whether there would be new business models or strategies employed either by themselves or by manufacturers they work with, which could indicate a shift towards a more service-based model. Additionally these two interviews

focused on the businesses' experiences in cooperating with public authorities or their attempts in doing so.

### 3.3. Data Analysis

After conducting the interviews the recordings have been transcribed. These transcripts have served as the basis for the data analysis. The following three subsections provide an overview of the transcription process and the data analysis process and the resulting coding scheme.

#### 3.3.1. Transcription Process

The transcriptions have been performed rather as what Oliver, Serovich and Mason (2005) describe as a “denaturalized transcription” as opposed to “naturalized transcription”. Hammersley (2010) has described this as “description” in opposition to “strict transcription”. That means the transcripts are not verbatim transcripts that account e.g. for each and every repetition of words or overlaps. Instead the transcripts have been cleaned up to some extent during the process of transcribing, to allow for a more coherent picture of the content that has been discussed later on. It was also not accounted for the duration of breaks. Laughter and similar utterances have been indicated in the transcripts when it appeared that it was necessary to provide context.

The main reason for opting for that kind of process was that the interviews were conducted in English, which is a language that is neither the interviewer's nor the interviewees' native language. Based on prior experience it was thus expected that longer breaks would occur simply for looking for the right words, and that interviewees would also be changing to different words as they speak, while trying to find the right words. This indeed proved to be the case and producing verbatim transcripts would likely have resulted in material that would have been a lot more difficult to coherently analyse for the purpose of this study. Another reason contributing to this decision was the initial plan to publish the full interview transcripts as part of the appendix to this study, which was still the case during the transcription process. This plan has been discarded during the process as it emerged that some content of the interviews could potentially be harming to the interviewees if it was made public. However, the benefits regarding the options chosen for



the transcription process still apply to the quotes that have been chosen to illustrate the findings.

### 3.3.2. Analysing Process

The transcripts have been coded inductively to build categories that eventually formed an understanding of the phenomenon (Gioia, Corley and Hamilton, 2012). Coding inductively was the preferred method due to the explorative nature of the interviews. Additionally, as described above, the interviews did not directly address the concept of Product-Service Systems and it would thus have been very hard to apply predefined categories stemming from the literature review as codes in this context. Furthermore the use of semi-structured interviews allowed for alterations of the interview guides to flexibly adapt to the situation. Having a pre-defined set of categories and codes going into the interviews would likely have limited the freedom to adjust the interviews as was the case and potentially limited the findings.

### 3.3.3. Coding Scheme

Based on multiple passes of coding of the transcripts of each of the six interviews a total of 63 codes emerged that were subsequently grouped into four thematic categories. These four categories are Activities, Barriers, Goals and Stimuli. The corresponding codes can be found in table 2: Coding Scheme: Activities & Goals and table 3: Coding Scheme: Barriers & Stimuli.

The Activities category captures the activities that were mentioned by the interviewees in 12 codes and will not be presented further, as it was mainly used to gain an overview of the activities the interviewees mentioned as relevant fields of operations.

The Goals category contains the five goals that emerged from the interviews and it was found, not surprisingly, that the goals of the public authorities and the goals of the businesses tend to differ as regards the profit focus which is much more prevalent with the two interviewed businesses. This discrepancy between an alignment of goals negatively impacts the joint creation of sustainability focused PSS and will be therefore be further detailed in chapter four, subsection 4.2 Barriers.

**Table 2: Coding Scheme: Activities & Goals**

Code Groups	Activities	Goals
Codes	Cooperation/Coordination	Climate Change Mitigation
	Data Production	Cost-Effectiveness
	Infrastructure Development	Profitability
	Maintenance	Sales
	Marketing/Awareness Creation	Sustainability
	Networking	
	Products & Services Creation	
	Projects	
	Providing Frameworks	
	R&D	
	Rental	
	Sales	

The Barriers category contains the 30 codes that emerged posing barriers to the creation of sustainability focused PSS that are not tightly connected to differing strategic goals between public authorities and businesses. The most frequently mentioned issues referred to difficulties in cooperating based on existing experience from the two interviewed businesses, the perceived differences in operating modes between public and private entities, regulatory frameworks and a significant need of investments for creating new services. These will therefore be discussed in more detail in succeeding subsections of section 4.2. Barriers.

The Stimuli category contains the 16 codes that indicate potential pathways for stimulating the joint creation of sustainability focused PSS, the most notable being procurement frameworks geared towards sustainable services, other regulatory frameworks favouring the creation of sustainable services and providing investments. These will be presented in more detail in section 4.3 Stimuli.

**Table 3: Coding Scheme: Barriers & Stimuli**

Code Groups	Barriers	Stimuli
Codes	Accessibility/Approachability	Cooperation/Coordination
	Communication	Data Production
	Competition	Infrastructure Development
	Cooperation/Coordination	Innovative Procurement Regulations
	Cost-Effectiveness	Intrinsic Values
	Different Modes of Operation (Public vs. Private)	Investments
	Fear of Resistance	Legal Frameworks
	Financing	Marketing/Awareness Creation
	Information	Projects
	Infrastructure	Public Procurement Values
	Intrinsic Values	Regulation/Planning
	Investment Need	Reputation/Image
	Lack of Involvement	Servitisation
	Lack of Political Power	Start-Up Financing
	Legal Frameworks	Subsidies
	Need for Transformation	Taxation Benefits
	Neutrality	
	Overwhelming Applications	
	People's Resistance	
	Political Power	
	Power to implement	
	Procurement Regulations	
	Profit Orientation	
	Regulations	
	Ressources	
	Scalability/Critical Mass	
	Scattered Responsibilities	
	Size of Operation	
	Taxation	
	Uncertainty	

## 4. FINDINGS

This chapter presents the findings from the six semi-structured interviews carried out between 22nd May and 21st June 2017. Section 4.1 details the findings regarding barriers for implementing Product-Service Systems. Section 4.2 details the stimuli that are either already in place or could be implemented. The main findings in brief are that jointly creating sustainability focussed services or PSS that promote cycling appears to be difficult due to very different strategic goals between public and private entities, that cooperation has proved difficult from the perspective of the two companies interviewed and that changes in the regulatory framework would be as necessary as ways of financing the required investment in order to further the creation of sustainable PSS which contribute to achieving climate change mitigation goals.

### 4.1. Barriers

This section presents the barriers that have been found to hinder potential creation of joint projects to create new innovative mobility services, which could also negatively impact the creation of new Product-Service Systems.

The main barriers found were difficulties in cooperating based on existing experience from the two interviewed businesses, the perceived differences in operating modes between public and private entities, the negative impact of regulatory frameworks and a significant need of investments for creating new services. With regard to the creation of solutions that promote cycling another relevant barrier found was the seasonality of cycling.

These barriers are presented in more detail in the following five subsections.

#### 4.1.1. Differing Strategic Goals

The interviews clearly show quite a difference in goals between public authorities and private businesses. The goals described here do not necessarily refer to goals regarding the creation of sustainable Product-Service Systems or innovative new services. Rather the goals presented here demonstrate what the interviewed indicated as their goals in general.

All the interviewed representatives from public bodies stated that sustainability was a main driver behind their actions, while from the businesses' perspective the single biggest driver was increasing sales.

For the Ministry of Transport and Communications it was stated that reaching the climate change mitigation goals is the underlying motivation of the new transport code legislation. However, even though that was the first reason mentioned, efficiency seems to play a key part as well and that appears to be geared towards cost effectiveness, though of course public transport operating at low capacity is also environmentally unsustainable:

*[...] basically what we're talking at larger sense is making the whole transport system more efficient.  
(LVM)*

*It's just idiotic, that we have regulation [...] prohibits you from combining different types of services. That doesn't make any sense. It makes it actually extremely inefficient, capacity and business wise, as well as particularly for the end user, now. (LVM)*

From the perspective of both HSL and HSY providing sustainable transportation services and reaching climate change mitigation goals is clearly a core driver of their operations, especially following the Paris Agreement:

*[...] they have a big emphasis on sustainable transport modes. So they try to find out that kind of transport services, which would be good competitors for private cars and that work is done in cooperation with residential and land use planning. (HSL)*

*Because we have this role to plan and produce public transport services through public transport we have a very big role in climate issues. And of course public transport has much lower emissions than private cars, but even inside public transport we are promoting those kind of modes which are the most environmentally friendly modes. (HSL)*

*Now there's a change, because we got, after the Paris Climate Contract, we got the new targets and also this regional transport planning system work, which is now starting, they are taking these climate targets more into their work. (HSY)*

From the perspective of the city, in this case the City of Vantaa, sustainability plays a key role in developing new and restructuring existing areas. At the moment the ongoing development project in Aviapolis aims for sustainability:

*We are building a sustainable airport city [...] (COV)*

And these kind of goals are supported by the local environmental services authority HSY by cooperating with the cities in those regards through projects and also by providing information on various climate measures:

*[...] our role is also to develop and organise many sorts of projects that will, in cooperation with the cities, help us to get the climate targets. (HSY)*

However, there still appears to be quite a difference in the role of sustainability between public authorities and private companies. For example the City of Vantaa is experiencing this issue concerning for example construction companies that are adapting only slowly to implementing sustainability goals into their operations:

*Maybe sometimes they speak differently. They have this brand that they are sustainable, but on the other hand they are thinking about the profitability and what's the profit for the investment and what's the return of investment, so... (COV)*

Sustainability was also not mentioned as a goal from the two interviewed business representatives. The independent bike shop owner stressed the fact that it is a very sales driven environment and that new business models are not something he notices being developed from the bike manufacturers that he is working with:

*[...] it is only a sales world, so purchase and sale. So I don't see any other concepts coming of renting or leasing or whatever, at least not towards us. (IBS)*

*Everything that increases their sales will be seen as positive, yeah. So if it will decrease the sales numbers it will be seen as negative, if I start to rent bikes and I don't buy anymore that amount I used to buy, that will be seen as negative, but as long as it is brings an increase in numbers then it will be seen as positive, because those companies they only look for selling their bikes, selling the amounts. (IBS)*

He did however point out that as a bike shop he could rent or lease the bikes. While there are checks in place that prohibit him from offering big discounts, such limitations are not enforced by the manufacturers if he were to rent or lease the bikes:

*But the sales prices, they're advised sales prices and it's no allowed to do crazy things about sales prices. Also the margins are not so big that you are really able to do so on the one hand, so they also keep the margins on a level that you don't have the possibility to do it, on the other hand they also will check you and they will contact you if they see that you are selling under price. Whether you start to rent or lease them out, in that you are totally free. (IBS)*

Nevertheless, as pointed out earlier it is a very sales driven environment and offering the bikes as rentals or lease might impact his overall sales numbers. While this might increase his individual profits in deriving more return per bike bought from the manufacturer it would likely become an issue for him as he could not increase the amount of units ordered from the manufacturer, which could negatively impact his deals.

The bike distributor also emphasised the importance of being able to sell products, for example in the context of operating the bike service points at Narinkkatori and Herttoniemi:

*One is for the service and the other one is for the sales. And they have the P'n'A over there, parts and accessories: helmets, locks, wires, etc. And also they have a couple of bike models, they also sell bikes from there. And that's really important. (BD)*

To sum it up, it can be said that the public authorities are increasingly implementing climate change mitigation goals and sustainability issues into their targets and actions while for private businesses the focus still remains on growing sales and increasing profitability, not necessarily with sustainability in mind.

#### 4.1.2. Difficulties in Cooperating

Both of the businesses interviewed described that they found it quite difficult to cooperate with public entities. The independent bike shop (IBS) had previously tried to cooperate with HSL to promote folding bikes, especially in connection with the western extension of the metro to Espoo. In his experience, trying to establish that cooperation takes a lot of

time and energy. This seems to be a consequence of the size of the public body where one has to deal with different and changing contact persons and decision making tends to take a lot of time. His experience is summed up in the following statements:

*Well my experience is that those organisations are very big, so you never have the right contact person and the initiatives they die in their beauty, as we tend to say. (IBS)*

*So you're always pushed away. [...] So after many weeks and months of swimming around in the organisation, suddenly somebody says: "Contact JCDecaux and make some advertisements there." (IBS)*

*Or that the organisations are too big, they don't know how to decide things. It's a waste of energy and a waste of time. (IBS)*

This is especially difficult in his case, where it is a family-owned independent bike shop and he does not have huge resources to put time and effort into such communications.

A similar experience was echoed by the bike distributor (BD). Though much larger in scale than the independent bike shop, they also described the cooperation with public authorities as rather challenging:

*Helsinki, the city, is not easy to work with. [...] everything was really really hard with Helsinki. (BD)*

*In November they said that you can have the place. In December they said: "No, we changed the people and have to make the [tender]" (BD)*

The timing issue appears to be one of the major issues. Decisions tend to take a long time, but once they are made, everything has to happen very quickly. This makes it very hard for the businesses to cooperate, as it is difficult to allocate the necessary resources regarding staff and inventory. Especially with regard to the inventory it becomes difficult, as that tends to require large investments. Therefore businesses are unwilling to take the risk that comes with the uncertainty of not knowing whether or when a cooperation will actually come into effect. Uncertainty in general poses a big threat to the businesses operations, this was not just described in the context of establishing a cooperation, but also regarding



practical matters, as illustrated by the example of outfitting a temporary bike service point with marketing material:

*But the bureaucracy is so that there are different kind houses, like buildings and then there is the public transport etc. where you have to go and that's the problem. We have to wait... and when we asked from the city whether we can put the signs over here and the flags over there that people see that we are over here and they said: "You need to have some kind of permission or something." And we then asked: "Where do we get it?" "Mb... Hard to know...hard to know... Just put it over there and if somebody says something, they solve it." (BD)*

Public authorities however, are also facing issues on their end when cooperating with private businesses. The previous subsection 4.2.1 already showed that the goals between public authorities and private entities are often not aligned which can be problematic for example in projects with a clear sustainability focus. Another issue can be managing the complex network of various stakeholders and getting them to agree on certain goals in joint projects:

*Yeah, but still, then the challenge is to get all the stakeholders—for example the Finavia (the airport operator), taxis, VR, HSL—to talk together [...] Yeah, that's the challenge. (COV)*

In summary, the lack of clear communication and timelines as well as uncertainties in responsibilities or correct contacts on behalf of the public authorities makes cooperating with them risky and often times very hard or impossible from the perspective of businesses. From the perspective of public authorities on the other hand strategic goals that strongly focus on growing sales and increasing productivity as well as managing complex stakeholder networks prove to be challenges.

#### 4.1.3. Operating Modes Public vs. Private

As outlined in the previous subsection 4.2.2 there are quite a few difficulties concerning the cooperation between public authorities and private businesses. It appears that many of them can be related to different operating modes of the two, which also reflect in their strategic goals. While the public authorities wish for reaching certain climate change mitigation goals the private businesses are mostly concerned with increasing sales and subsequently revenues. As a result of that they operate differently and it appears that they

face issues coming together. While public authorities usually have a large amount of employees that do not directly depend on economic success of the whole endeavour this is very different for the private businesses who have to make sure they stay profitable. From that perspective they often cannot adapt to schedules or processes in place at public authorities:

*And for us, when you're in the business you need to run your daily business, that's very important. So we cannot wait too much on the politicals [sic!] or what is going on. We just need to do our daily business. (IBS)*

*On the fair they came to the [company name] stand and asked: "Would you like to do it?" And two weeks after that we had a meeting and then they said that you should open it in six weeks. [...] So this is the thing. That was pretty late. And that is the reason that I know they've been talking with other companies, but when they heard the schedule they were like "No, thank you!" Because when you need to have the workers over there and everything and the pay desk and all the deals done and everything it's not that easy. (BD)*

From the perspective of the bike distributor there seemed to be a lack of understanding in public authorities that there needs to be a possibility for the businesses to actually make a business and that they cannot only offer services for free out of good will and with little time to prepare:

*And I think this is the first year that they have understood, that if they want to have a company over there, and if they want service of good quality, there have to be possibilities to make a business. (BD)*

*Because if there was no business and there will be no margin, no-one wants to do it. (BD)*

In sum, it appears that in order for a more successful cooperation between public authorities and private businesses a better understanding for the different operating modes has to emerge on both sides and measures have to be taken that alleviate the issues resulting from those differences. It has to be noted though, that both interviewed businesses represent SMEs and that this finding might not be generalisable to all types of businesses regardless of their size.

#### 4.1.4. Regulatory Frameworks

Linked to regulatory frameworks, two main barriers were brought up in the interviews: the requirements of existing procurement regulations and a lack of relevant legislation to mandate sustainable solutions. HSY and HSL were talking about how procurement regulations can in fact make it quite difficult to further the creation of new innovative solutions. The main reason for that is that procurement regulations usually require three offers for any tendered solution. In cases where a solution is so new that there are no competitors it is impossible to procure these solutions. This was expressed by HSY as follows:

*In this case, when the business idea and the concept came from the cooperation with the Aalto University and this kind of course, we are... It's easy for us to be involved, but if we get some sort of business concepts or ideas from outside from our main work in Finland we have this kind of procurement system that we have to have these at least three partners, which we are inquiring the prices and we can't, like, take one company and work with them, but we have to have this official, or not that official procurement system, but what goes to our procurement rules. So it's a problem. (HSY)*

*Because in many cases you don't have the competitors. It's the problem that when you get the new business idea it's the only and you can't make the procurement system with three different companies [...] (HSY)*

HSL described a similar problem in relation to the electric busses that they were developing in cooperation with Linkker and stated that it would likely have been an issue if Linkker would have offered to operate the busses as well.

The City of Vantaa outlined how a lack of legislation which mandates or favours new or more sustainable solutions effectively hinders their implementation:

*I've been a long time trying to get electric vehicles to Vantaa and these electric vehicle charging systems, but nothing happens before the legislation really comes and says that the city has to build these charging points to the area. (COV)*

As long as this legislation is lacking it appears to be more difficult to convince companies to invest in infrastructure or services that do not appear to be immediately profitable in the short term.

In sum, it appears that the current regulatory framework is hindering the development and implementation of innovative new services that increase sustainability as the existing procurement regulations cannot support procuring new offerings and legislation mandating or favouring more sustainable solutions is lacking.

#### 4.1.5. Need for Upfront Investment

The need for investments to create new services around a certain product is often high and can significantly hinder the creation of new services. This is especially true for creating mobility services around any type of vehicle. One example provided by HSL is that of introducing electric buses into the existing public transport network. HSL has developed such buses in close cooperation with Linkker as a manufacturer to fit the specific needs of public transportation in the Helsinki metropolitan area, but neither Linkker nor HSL itself would operate these buses. Bus services in the Helsinki metropolitan area are tendered out and different bus operators compete for the lines. However, none of the operators would buy the buses directly, as that would have required a very high upfront investment. Additionally, with electric buses one also needs to take into consideration the necessary charging infrastructure to operate the buses. Since no operator was willing to invest into electric buses on their own, HSL eventually made the decision to acquire the buses and to lease or rent them to the operators.

Connected to offering bike rentals at the Narinkkatori bike service point, as used to be done before the city bikes were implemented in Helsinki, the bike distributor also hinted at the significant costs that are related to that:

*And then you need to have 150 bikes from somewhere. It is not that easy to get the right kind of bikes. Ok, they were already waiting in our stock, because we knew he was willing to do it, so we put them over there. And then you need to have employees and everything. (BD)*

A very big financial issue was to allocate the 150 bikes needed to operate the service and in that specific case the difficulties in cooperating with the City of Helsinki made this an even

more difficult investment, as the decision to have the company operate the rental business there was made very last minute after some back and forth. This meant that the company was facing a big uncertainty about whether or not to make the investment and it was not easy to secure the necessary financing for it.

#### 4.1.6. Seasonality of Cycling

Concerning specifically promoting cycling, one key barrier to developing new services is the seasonality of cycling, meaning the impact of weather conditions on the popularity of cycling as transport mode choice. The representative of the bike distributor summed this up as follows:

*We don't sell bikes during twelve months in the year. So the season is from end of March till end of September, maybe end of November. But then comes the winter. So if it's an expensive place and you have to pay the whole winter for the rent and employees and everything, it's not that easy. Or then we have to set the prices so high that nobody comes in. (BD)*

This very well illustrates that bike related businesses are struggling to operate in areas that would be particularly well suited to offer cycling related services, as they cannot afford the rents around the whole year required to stay in these prime locations.

## 4.2. Stimuli

This section presents the stimuli that have been found to potentially help in creating joint projects, achieving climate change mitigation goals or the promotion of cycling in particular. The main stimuli found to promote the creation of innovative new services that help mitigate climate change in general were sustainability promoting strategic goals, regulatory frameworks which further the creation of sustainable solutions, projects and trials as a tool for testing and developing new solutions and public investments which can be a way to develop new services that are otherwise too cost intensive to be implemented by private businesses. These stimuli will be presented in more detail in the following subsections 4.3.1 through 4.3.4. In relation to specifically promoting cycling, additional measures mentioned by the interviewees were the introduction of the City Bikes, marketing campaigns and improving conditions which allow to take a bike on commuter trains as well

as supporting bike businesses by offering seasonal spaces at cheap rents and incentivising buying bikes through taxation and public subsidies. Those will be presented in more detail in subsection 4.3.5.

#### 4.2.1. Sustainability Promoting Strategic Goals

With regard to regulatory frameworks the interviews show that climate change mitigation and sustainability are increasingly becoming part of public decision making and regulatory processes. As already touched upon in subsection 4.2.1 the Ministry of Transport and Communications currently finds itself in a process to make systemic changes to transport related legislation, claiming that sustainability is a major driver behind this ongoing process:

*[...] in order for us to kind of reach, or come anywhere close to reaching emission reduction targets, it has to be made changes on a systemic level. And that's what the transport code is trying to do.*  
(LVM)

Concerning the promotion of cycling in general HSL emphasised its goal to promote environmentally friendly modes of public transportation. These modes are especially rail-borne modes such as commuter trains, trams and the metro:

*We have this transport system planning unit, which makes plans for the whole transport system, not just public transport, but the whole transport network inside 14 municipalities and that's the whole Helsinki region. And they have a big emphasis on sustainable transport modes.* (HSL)

*[...] even inside public transport we are promoting those kind of modes which are the most environmentally friendly modes.* (HSL)

Additionally HSL highlighted the fact that with its holistic approach to transport system planning it is not just aiming at promoting public transportation over the use of private cars but it also aims at promoting walking and cycling as sustainable modes of transportation:

*That's also in that transport system planning, the prioritised transport modes are walking, cycling and public transport. And that's also in HSL's strategy that we try to increase the use of walking, cycling and public transport.* (HSL)

The City of Vantaa aims at building a sustainable airport city and though it appears at times unclear how to achieve that in concrete terms this goal serves as a guiding principle in making procurement decisions and thus this strategic goal supports the creation of sustainable solutions to some extent as well.

#### 4.2.2. Regulatory Frameworks

The strategic goals that emerged from the interviews and were presented in the previous subsection 4.3.1 do not directly lead to the creation of new sustainable solutions per se. However, they are a necessary foundation to further the creation of new innovative services and to establish a demand for sustainable solutions on the public side. The most important tool local public authorities named related to furthering the creation of sustainable solutions in general is that of procurement regulations that demand environmentally friendly solutions and award extra points for sustainable offerings. This was concordantly stated by HSL and HSY as well as by the City of Vantaa:

*Or, for example, when we are tendering we give more points to bus companies which have the cleanest bus fleet. (HSL)*

*And besides of those points that we give to more sustainable buses we also have this bonus system, that we give awards to those bus companies who have the most... less emission vehicles. (HSL)*

*We have the environmental aspects in our procurement system, so if I'm making a quotation I will always put some pressure in these environmental issues and ask companies to tell how they have arranged these systems in their work. [...] But it is in our procurement system and also cities are having that also. (HSY)*

*I think that the best tool a city has in its hand is these requirements in the public procurement that we are doing. I think in there we can use the sustainability as a main criteria, or, you know, when you're comparing different offers, then you can value the sustainability more and then you can select that one. (COV)*

However, HSY pointed out that new tools need to be developed in order to address the aforementioned barriers that existing procurement regulations pose in relation to requiring at least three competing offers. In order to achieve that new processes, referred to as “market dialogue” are being tested, to circumvent that hindrance:

*But there is one solution that has been developed in the Kalasatama project, it is this kind of “market dialogue”, do you know what it means? It’s like that there might be a competition where we could find these promising business ideas and then we could do it by “market dialogue” so that these most promising ideas could be piloted and tested in cooperation with the city and the other public actors and this way help the companies to develop their businesses. Because in many cases you don’t have the competitors. (HSY)*

Taxation was only briefly touched upon by the Ministry of Transport and Communications and whether or not changes should be made to support the creation of innovative new services which better address sustainability issues in transportation and how it could be done was not clearly answered.

In sum it can be said that sustainability and climate change mitigation goals are increasingly being implemented into legislation and public procurement processes and that local public authorities perceive their procurement guidelines that favour sustainable offers over others as a meaningful tool to further the creation of sustainable solutions. However, they are seeking better solutions to support the creation of innovative solutions, as the existing procurement regulations only work well if a market for the solution in question is already established.

#### 4.2.3. Projects and Trials

Apart from procurement regulations local public authorities emphasised the importance of projects and trials for creating innovative and sustainable new solutions:

*We’re using EU funding to support new innovative mobility solutions and creating them and we are just starting a new project in autumn with Helsinki and Espoo, to find new last mile solutions and to combine the traditional companies, for example travel companies, you know hotels and everything related to traveling, and to combine those companies with the new service providers. (COV)<sup>8</sup>*

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<sup>8</sup> The project alluded to in this statement is the Perille Asti project, which Bikefy has subsequently become a part of as well. More information on that project can be found at [http://www.vantaa.fi/hallinto\\_ja\\_talous/tyo\\_ja\\_clinkeinot/elinkeinokehittaminen/6aika/perilleasti.aspx](http://www.vantaa.fi/hallinto_ja_talous/tyo_ja_clinkeinot/elinkeinokehittaminen/6aika/perilleasti.aspx).



*[...] the city is the enabler. They can enable. As I said that we can offer this as a platform for new businesses to come and test and pilot their things. (COV)*

*[...] we have this project called “Smart MR - Sustainable measures for achieving resilient transportation in metropolitan regions”. We are coordinating it in the Helsinki region and our target in that is to develop low carbon station areas. So we are connected to low carbon transportation and transport system in this area. (HSY)<sup>9</sup>*

*We had a project called “Julia 2030”. It was five-six years ago and in that project we had this work package for producing this kind of environmentally friendly procurement system for the capital region. (HSY)<sup>10</sup>*

*And we are in many, many projects where they are developing new, lower emission vehicles in buses. (HSL)*

These projects are often funded to a large extent through different European funding instruments such as the European Regional Development Fund. Due to the principles and limitations of these funds it is however usually not possible to invest in hardware. This can pose a challenge when the creation of a new service requires significant upfront investment.

#### 4.2.4. Investment

Concerning the substantial upfront investments that can be necessary in order to create new sustainable solutions, HSY pointed out that while there are institutions such as Tekes (nowadays Business Finland) and e.g. the Smart and Clean Foundation, it can be very difficult to find a way to finance new services:

*But another place or organisation which could finance these kind of pilots would be Tekes [...] But in their target is these kind of business ideas which could be exported, so they are not financing this*

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<sup>9</sup> This project was the initial context in which the Bikefy concept was developed as part of a study project at Aalto University in spring 2017. More information on the Smart MR project can be found at [https://www.hsy.fi/fi/asiantuntijalle/ilmastonmuutos/hankkeet/Sivut/smart\\_mr.aspx](https://www.hsy.fi/fi/asiantuntijalle/ilmastonmuutos/hankkeet/Sivut/smart_mr.aspx).

<sup>10</sup> More information on the Julia 2030 project can be found at <https://www.hsy.fi/julia2030/Documents/julia2030/en/Pages/default.html>.

*local development if they don't see that this business idea could be developed. And also, the "Smart and Clean Foundation" is one actor who can [...] support the financing which is made by Helsinki Uusimaa regional council, because the money is delivered from there. So it's a quite difficult system [...] (HSY)*

One successful example was given by HSL in the context of taking electric busses into service. That was only possible after HSL bought about 12 of them from the company they were cooperating with in the development phase:

*For example HSL did buy, this was exceptional, we did buy buses from Linkker—was it 12 buses, electric buses, that we bought from Linkker—and then it was so that we wanted to get them running in the public transport network and then we will later on sell them to the bus operators. So this was also quite, I think, a good system to get them to the traffic. Because Linkker isn't an operator, it's just a manufacturer of buses, so it couldn't come and compete in our tenders. (HSL)*

As no bus operator was willing or able to invest the necessary money into acquiring the busses and setting up the necessary charging infrastructure HSL decided to invest themselves and to subsequently lease or sell them to the bus operators to provide the service. This indicates that public investment can be a feasible and also very necessary way of developing innovative new services that require a big upfront investment which cannot be provided by individual private businesses.

#### 4.2.5. Measures to Promote Cycling

Regarding specifically promoting cycling, a number of measures were mentioned. HSL mentioned the City Bikes as one very concrete example of how cycling is promoted in the Helsinki metropolitan area and that they are undertaking an experiment to allow taking bicycles on commuter trains also during rush hours:

*And for example the city bikes are [...] a concrete action how we are promoting cycling. And of course we make marketing campaigns. And now we are allowing to take a bike to the commuter train even in rush hours, starting the 19th of June. So it will be an experiment lasting one year, but hopefully that experiment will go fine and also in the future people can take their bike to the commuter train. So it's one way how to... That it's easier to combine walking, cycling and public transport with each other and they together are a better competitor to private cars. (HSL)*

*In addition to the commuter trains, HSL also mentioned that changes will be made concerning VR's tariff system simultaneously to the start of the aforementioned experiment to allow taking bikes for free also on trains that go beyond the HSL area but are part of VR's near distance traffic. This includes routes for example to Järvenpää and Riihimäki. Allowing bikes for free on commuter trains improves the combinability of public transport and cycling to enable sustainable traveling also on longer distances.*

The bike distributor, whose subsidiary, is operating the bike service points at Narinkkatori and the Herttoniemi metro station highlighted that providing services directly at the relevant public transport hubs. He also pointed out the importance of infrastructure to safely lock your bikes, ideally underneath a roofed area. Problematising safety concerns, he pointed out that being present at a station as a bike service operator could give an increased feeling of safety as commuters would perceive the service operators as someone who looks after the bikes as well. However, as outlined in subsection 4.1.6, he did point out that the seasonality of cycling makes it next to impossible for bike service providers to rent spaces at for example metro or train stations. From his point of view providing more spaces such as the one at Narinkkatori and the Herttoniemi metro station would be a very suitable way of supporting the creation of services that serve to promote cycling and that more such spaces should be offered at lower rents, as promoting cycling would benefit the whole city:

*They should offer more places near the public transport at a low price, because [of] our season...*  
(BD)

Additional measures to promote cycling in general that were mentioned, not surprisingly, by the business representatives, were taxation and subsidies. With for example cargo bikes being quite expensive goods, the independent bike shop owner argued that lowering the tax rate to incentivise people buying them could be a suitable way forward. Additionally he argued that subsidies for purchasing electric (cargo) bikes, as are increasingly popular in many cities or countries in Europe could be a feasible solution which was seconded by the bike distributor as well:

*And it's quite ridiculous again to see that 24%, so almost one quarter of the product, is paid to tax, to VAT, and sincerely I don't understand why a bike is taxed as high as alcohol. So, it's not a negative thing, but it's taxed as something bad. (IBS)*

*For example, what we see in other countries, that people get subsidies when they purchase e-bikes or purchase cargo bikes and get rid of the car. (IBS)*

*[...] the government should help companies to have bikes over there. Now if you work in a company and they offer you an e-bike, if you use it you have to pay taxes on it, which is strange. (BD)*

*Also you have to support the companies, because there's a lot of people in Finland who can't afford to buy a 1500€ bike, even a 2500€ bike. There's no money for it. (BD)*

To sum it up, measures that were mentioned as suitable to promote cycling were the introduction of the City Bikes, as well as marketing campaigns and regulations that enable taking a bike for free on more routes at extended times as well as supporting bike businesses by offering seasonal spaces at cheap rents and incentivising buying bikes through taxation and public subsidies similar to the ones existing in other European countries.

## 5. DISCUSSION

This fifth chapter will discuss the findings from the interviews presented in the preceding fourth chapter in context of the findings from the literature research presented in chapter two. I will also relate own experience gathered throughout the process of developing the Bikefy concept further alongside the thesis writing process. In order to answer the main research question of how public authorities can contribute to the creation of viable Product-Service-Systems to achieve climate change mitigation goals for transportation by promoting cycling the following three subsections will first discuss the three subquestions regarding the role that public authorities currently find themselves in concerning furthering such innovations (subsection 5.1), the opportunities (subsection 5.2) and the challenges (subsection 5.3) that exist for said authorities in furthering the creation of new innovative PSS in the context of public transportation with a focus on promoting cycling. Subsection 5.4 will then summarise these outcomes to provide an answer to the question of how public authorities can contribute the creation of viable Product-Service-Systems.

### 5.1. Role of Public Authorities

As presented in subsection 2.3.5, most of the existing literature on Product-Service Systems discusses the role of public authorities primarily from a perspective of legislators. In that regard Mont (2002b) outlined how the many PSS solutions in the field of chemical management services or recycling have been created as a response to legislation in that field and Goedkoop *et al.* (1999), Heiskanen and Jalas (2003), Halme *et al.* (2007), Baines *et al.* (2007) and Tukker (2015) all highlight the importance of creating further legislative frameworks that demand sustainable solutions. Vezzoli *et al.* (2015) pointed out that in addition to that public authorities as procurers of services can play an important role in furthering the creation of sustainable Product-Service Systems by demanding sustainable solutions.

The interviews conducted for this study support these positions. HSL, HSY and the City of Vantaa all stressed the importance and effectiveness of procurement regulations that favour sustainable solutions in the context of reaching climate change mitigation goals.

The findings do however indicate that public authorities can also take a more active role in furthering the creation of sustainable new services. This shift away from only new regulatory frameworks towards a more active role can be observed especially on the local level: There, hosting and coordinating projects and trials that actively seek to test out new services and promote new, sustainable solutions, especially with a focus on mobility and transportation, appear to be a feasible option. Through these projects, public authorities in the Helsinki metropolitan area are trying to co-create new solutions with private businesses and provide a platform for businesses to test out new business models. The strategy of the Government of Finland (Government of Finland, 2017, 2018) based on Sitra's roadmap to a circular economy (Sitra, 2016) supports this role well.

## 5.2. Opportunities for Furthering the Creation of PSS

As mentioned in the preceding subsection the literature pointed out that creating legislation such as in the field of chemical management services and recycling can significantly stimulate the creation of innovative new PSS solutions. Additionally it was outlined that public procurement is currently one of the most powerful tools to create a demand for sustainable solutions. This was reinforced by the interviewees from the public sector. Therefore creating more targeted legislative frameworks that favour the provision of services over the sales of products are a significant opportunity in furthering the creation of PSS to achieve climate change mitigation goals. The strategic goals to proceed in that direction are already clearly formulated, for example in the Finnish Government's action plans (Government of Finland, 2017, 2018) as well as its goal to reach carbon neutral transport by 2045 (Liikenne- ja viestintäministeriö, 2018) and Helsinki's Carbon Neutral Action Plan (City of Helsinki, 2018). The necessary next step is to rather quickly implement legislation that actually enforces these goals, such as for example vehicular traffic pricing (congestion charging). This notion was particularly stressed by the interviewee from the City of Vantaa, who emphasised that without the appearance of relevant legislation it is and will remain very hard to implement sustainable solutions that might currently come at an economic disadvantage when compared to unsustainable solutions.

Restricting the use of private cars or raising the cost of driving through measures such as vehicular traffic pricing not only increases the possibility of reaching climate change

mitigation goals in the field of transportation but also opens up opportunities for innovative new services arise and possibly become financially viable, for example such that contribute to the goals of increasing walking and cycling.

Another instrument with the potential of supporting the creation of sustainable PSS solution is the further implementation of procurement guidelines that demand sustainable solutions. HSY has been doing significant work in that regard, but mentioned that it is lacking information from the municipalities on the extent to which these guidelines are currently being implemented and followed. In order for such regulations to reach their full potential, It Is thus necessary to improve the Information flow between the municipalities and HSY on the actual Implementation of sustainable procurement regulations. One tool to alleviate this could be to introduce mandatory guidelines on tracking, documenting and sharing the award criteria applied in all public procurement decisions. Considering that such enforceable measures do not currently seem to exist leaves the impact of existing regulations on promoting sustainable new solutions rather low.

However, while procurement regulations were pointed out as a very useful and effective tool by the interviewees from HSL, HSY and the City of Vantaa, they also highlighted the fact that one crucial disadvantage in these regulations is the requirement for three competing offers. This significantly limits the possibility of furthering the creation of new sustainable offerings if they are so different from other already existing alternatives that they would not fit a tender and were to face the issue of lacking competition if the tender was targeting specific innovations. This coincides with Temmes *et al.* (2014) highlighting of the need for policy instruments that support market formation for innovations, specifically in the context of extending current public transport offerings. One alternative path to this would be “market dialogue”. This option was mentioned by HSY and describes a form of competition where promising new ideas would be able to enter. The winning concepts could then be piloted together with public actors to further the creation of innovative new solutions and help companies to try out new business models. Another example would be the just concluded HSL IdeaLab<sup>11</sup> competition which was open to both businesses and

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<sup>11</sup> See <https://www.hsl.fi/idealab> for further details.

natural persons and run as a design competition in accordance with Sections 58 and 59 of the Act on Public Contracts and Concessions of Entities Operating in the Water, Energy, Transport and Postal Services Sectors (1398/2016). I took part in that competition with the Bikefy concept and while the possibility to compete without a registered business was a big advantage, it still required a rather advanced and detailed calculation. In the context of a competition that seeks to gather innovative new ideas, this requirement can constitute quite a barrier for many small businesses at the start of their activities. It can be pretty difficult to develop a concrete budget for these early-stage businesses that is able to compete with the amount of resources and financial data of established larger corporations also running in the same competition. However, implementing such new models to a greater extent and finding ways of procuring new solutions that provide sustainability benefits, with a stronger emphasis on Innovation and alignment with climate mitigation goals rather than marketability, provides great opportunities to further the creation of innovative new PSS solutions.

Projects, particularly those funded largely through EU funds such as the European Regional Development Fund, appeared to be a very important tool for public authorities to test and promote innovative new services as described by HSL, HSY and the City of Vantaa. This kind of strategy did not appear of particular relevance in the literature presented in chapter two. In cooperation with an existing bike shop, I was able to participate in a tender for innovative new mobility solutions with the Bikefy concept. The tender specifically addressed the last mile issue and the accessibility of Vantaa to tourists without using cars as part of the Perille Asti project<sup>12</sup>. As the application was successful, I can say from a personal perspective that this indeed helps in testing out new services and studying the feasibility of new business models. However, in this particular case, the participation required an existing company for the application, which limits the possibilities of innovative new ideas to be tested. What makes such projects and trial phases challenging for testing PSS solutions is the rather limited funding which does not cover any big upfront

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<sup>12</sup> See

[http://www.vantaa.fi/hallinto\\_ja\\_talous/tyo\\_ja\\_elinkeinot/elinkeinokehittaminen/6aika/perilleasti.aspx](http://www.vantaa.fi/hallinto_ja_talous/tyo_ja_elinkeinot/elinkeinokehittaminen/6aika/perilleasti.aspx) for further details.



investments in order to produce an innovative new service without significant own funds, which in turn can be difficult to acquire.

Additionally, the schedule of such projects can be very challenging for companies to work with. In this particular case, the time between the procurement decision by the City of Vantaa and the official start of the project was merely two weeks, which were also the grace period in which the decision could have been overturned. This makes it difficult for businesses to fulfil the necessary requirements and might disincentivise participation. Scheduling and communication issues were also discussed by the bike distributor in the context of cooperating with the City of Helsinki to establish the bike service points at Narinkkatori and Herttoniemi. Additionally there was an issue of unclear contacts concerning certain practicalities. The independent bike shop also experienced issues finding the right contact person to discuss the joint promotion of combining public transport and cycling. It thus seems as if projects and increased cooperation between public authorities and private businesses can indeed be a very good way to test new services and promote cycling in general, but in order to have an even higher impact improvements should be made that make schedules and decision-making-processes more transparent and provide clear contact persons to streamline communication. These improvements would provide great opportunities in jointly developing new innovative service solutions to promote cycling.

The bike industry representatives also mentioned the necessity of subsidies and the benefits a lower taxation could have on the promotion of cycling. These measures could lower access barriers especially regarding costly electric (cargo) bikes as one-time benefits for buyers of new electric cargo bikes in many cities and countries around Europe have shown. While such measures could indeed promote cycling, a one-time subsidy on buying a bike would not necessarily help furthering the creation of new sustainable PSS solutions that promote cycling. Here, an incentive that would support the actual use of bikes instead of merely buying them would be much more beneficial. This could for example happen in taxing bike maintenance services lower to support the upkeep of existing bikes that are actually being used. At the same time this might stimulate the creation of new jobs in the field of bike servicing, as people might use cheaper maintenance services more frequently.

In sum it can be said that opportunities for public authorities to further the creation of PSS to reach climate change mitigation goals by promoting cycling lie, firstly, in turning strategic goals into binding legislation, secondly, in further integrating sustainability measures into procurement regulations and, thirdly, in adapting procurement systems that do not exclude innovative solutions for lack of competition and, fourthly, in making improvements regarding trials to the way the cooperation and communication between public authorities and private businesses is currently dealt with.

### 5.3. Challenges for Furthering the Creation of PSS

By far the biggest challenge for creating sustainable PSS solutions appears to be the necessary change in business models of existing companies (Mont, 2002a, 2002b; Baines *et al.*, 2009) which leads to increased needs for capital investments (Mont, 2002b; Tukker, 2004, 2015; Halme *et al.*, 2007; Baines *et al.*, 2007) and different requirements for personnel (UNEP, 2002; Baines *et al.*, 2007; Vezzoli *et al.*, 2014, 2015; Tukker, 2015; Annarelli, Battistella and Nonino, 2016).

The two interviewed businesses indicated that there does not seem to be a big change away from product sales driven models towards more service-based models in the bike industry. Additionally, the bike distributor confirmed the needs for higher investments and operating costs when describing the operations of the bike service stations past and present where additional personnel was necessary and large amounts of bikes had to be allocated for the rental service before the introduction of the city bikes. While longer lead times in the decision making and more certainty in the process early on through communication from the City of Helsinki could have improved the situation, the financial burden would still remain with the service provider. After the interviews had already taken place, the BSR Electric<sup>13</sup> project, which HSY is coordinating in the Helsinki metropolitan area, started with the goal of promoting e-bikes. At a meeting on 30th August 2018, the results of the first phase were presented. The project coordinator Petteri Nisula shared that one of the main difficulties for HSY had been to rent e-bikes for several representatives from the bike

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<sup>13</sup> See <https://projects.interreg-baltic.eu/projects/bsr-electric-121.html> and <https://www.bsr-electric.eu> for further details.

industry argued that offering e-bike rentals are not economically feasible for them at the current stage due to the maintenance required. This further supports the notion outlined by Mont (2002b), Tukker (2004) and Baines *et al.* (2007), that existing companies are experiencing issues financing the necessary products as well as providing the ongoing service when trying to create service-based solutions. In the highly sales oriented environment the current bike industry seems to incorporate as outlined by the independent bike shop and the bike distributor, it seems to be difficult to motivate existing companies to offer more service-oriented solutions even though the demand is created through projects by public authorities.

Another example in which high investment costs were an obstacle to creating more sustainable solutions was provided by HSL in the context of taking electric buses into service. None of the existing bus operators appeared to be willing or able to upfront the necessary investments even in light of the advantages this would have brought when competing in tendering processes due to HSL's procurement guidelines and bonus systems clearly favouring such solutions. HSL therefore made the exceptional decision to acquire the buses itself in order to subsequently provide them to bus operators for the provision of services. It appears that the procurement regulations and bonus systems are not incentive enough to motivate highly capital intensive investments into more sustainable solutions.

Projects offering possibilities for trials of new service-based solutions also require that the participating companies are already interested in or even convinced of the benefits of developing PSS solutions as Vandermerwe and Rada (1988), Mont (2002b) and Mont (2002a) emphasised the fact that restructuring existing companies towards offering more service-based solutions requires dedication from top management. If investment needs are significantly higher than financial compensation within such projects, companies that are not already convinced might not want to try out new service solutions based on that.

One potential solution could be focusing on the creation of new businesses instead of transitioning existing companies towards more service-based business models. This was however not widely discussed in the literature as it mostly outlined PSS solutions as a strategic way for existing businesses to adapt to changes and remaining competitive. The necessary investments could be lower for new businesses with regard to the restructuring

process of the company and acquisition of new skillsets as the business could be built from scratch around the service dominant PSS business model. However, significant investments are still necessary for acquiring the products the service is build and the necessary maintenance costs also need to be taken care of. From my personal perspective trying to establish Bikefy as a company and therefore exploring various ways of financing it as a start-up, this proves to be a big challenge as especially regarding the acquisition of necessary investments for financing the bikes.

In sum it can be said that huge challenges exist concerning providing or securing the necessary investments that are required to create sustainable PSS solutions. The current tools that public authorities are mostly employing—sustainable procurement strategies, legislation and organising projects to test out new services—do not appear to spark a significant change towards more service-based solutions in the bike industry which could lead to reaching strategic goals of promoting cycling as a sustainable mode of transportation quickly.

#### 5.4. How to Further the Creation of PSS to Mitigate Climate Change by Promoting Cycling

The main research question of this thesis was how public authorities can contribute to the creation of viable Product-Service-Systems to achieve climate change mitigation goals for transportation by promoting cycling. By discussing and answering the three subquestions regarding the roles of public authorities, the opportunities and the challenges of furthering the creation of innovative PSS in the preceding three subsections of this discussion chapter, the answer is of course manifold. Many of the findings are rather general and not specifically limited to the creation of new solutions promoting cycling, but rather innovative new solutions overall.

Public institutions with legislative powers need to quickly develop legislation that favours the provision of services over increased sales of products as well as such that supports the already existing strategic goals of promoting cycling. Those could for example include legislative changes regarding the taxation of car usage and implementing vehicular traffic pricing. Providing such legislative frameworks would increase the power and legitimation

of local public authorities to implement further concrete actions that promote sustainable solutions in general as well as cycling in particular. All public institutions should make increased use of procurement regulations favouring sustainable solutions. Measures that demand accountability and transparency regarding the procurement of sustainable solutions should be implemented, so that relevant local authorities such as HSY can track progress and develop further guidelines how to promote sustainable solutions. In addition to procurement regulations new models need to be developed that benefit innovative new solutions especially in cases where no competition is yet available. Furthermore, local public authorities should continue to organise projects that enable testing new services and business models.

The recently published IPCC special report on global warming (IPCC, 2018) highlights the urgency of developing innovative new solutions to reach climate change mitigation goals and emphasises that everything possible should be done to limit global warming to no more than 1,5°C on average. With the biggest challenge being the transformation of existing business models towards service dominant PSS solutions requiring significant investments the question is which role public authorities can play in that regard. It appears that current investment and financing options are not sufficient for existing businesses to make the transformation quickly or new businesses to create competing PSS solutions. This problem is additionally augmented in the context of developing solutions that promote cycling as seasonality adds an extra challenge to creating profitable PSS solutions. Regarding for example a solution like Bikefy, which builds on the existing public transport offering to promote cycling at least for the last mile, this is a big challenge as it mainly aims at converting car commuters to cyclists and users of public transport. While cycling is becoming increasingly popular also during the winter season (Helsinki City Planning Department, 2017) in particular people who are used to the warmth and comfort of commuting by car might initially be very reluctant to extend the cycling season into the colder months. This effect of seasonality poses a significant threat to profitability and is one reason I personally experience difficulties in raising funding be it through bank loans or venture capital funds. One solution of addressing the seasonality in enabling the provision of cycling related services could be for local public authorities to reserve seasonally shared spaces at for example train and metro stations and somehow facilitate a

switch of service offerings leaving those spaces to cycling related businesses during the summer season and to winter related businesses during the colder months of the year. Furthermore, it might be that public authorities could significantly further the creation of sustainable PSS solutions to reach climate change mitigation goals by promoting cycling with the help of investment tools that enable existing and upcoming businesses to overcome the barrier of increased investment needs. How such tools could look like is beyond the scope of this research and should be the topic of future research.

## 6. CONCLUSION

The purpose of this thesis was to investigate how public authorities can contribute to the creation of viable Product-Service-Systems to achieve climate change mitigation goals for transportation by promoting cycling. The reason for doing so was that in order to reach climate change mitigation goals for the field of transportation a modal shift away from the heavy reliance on private car based mobility needs to take place. Public institutions on global, international, national and local levels have therefore put forward strategies and action plans that aim at promoting walking, cycling and the use of public transportation in order to achieve the ambitious climate change mitigation goals. Product-Service Systems provide a potential for offering sustainable solutions by decoupling economic growth from increased resource consumption. The literature agrees that this significant potential for unlocking environmental and social benefits is not inherent in PSS per se, but needs to carefully be designed into the individual solutions. However, if designed right, PSS business models, specifically use- and result-oriented ones, appear to be a very suitable way to address the challenges of climate change mitigation and to adapt to changes in the legislative framework that further implement these goals. There currently are a number of significant barriers though that hinder the widespread implementation of sustainable PSS. The main challenge is to make the necessary changes to business models, which require significant transformations for most existing businesses that require significant financial investments. The literature currently mainly focuses on the transformation from a perspective of existing businesses and discusses the influence of public institutions mainly from the legislative perspective and in the role of procurers. While legislation and public procurement regulations offer great opportunities already, local public authorities are also taking more active roles in carrying out projects in which new solutions are actively tried and platforms for testing new business models are provided. This role appears not to be widely discussed in existing literature on PSS yet. It was found that local public authorities are facing issues choosing innovative new solutions in procurement processes as existing procurement regulations require three competing offers, which are usually not obtainable in cases where a solution is so new that competitors do not exist yet. Concerning creating innovative PSS solutions that specifically promote cycling it was found that the seasonality

of cycling further complicates the development of such solutions. The limited amount of months annually during which such solutions could be offered profitably significantly exacerbates the financing issue that already exists with sustainable PSS solutions in general. It should be further investigated which role local public authorities could play in alleviating this difficulty.

## 6.1. Implications

### 6.1.1. Theoretical Implications

The findings of this work imply that public authorities can and should take a more active role in furthering the creation of sustainable PSS offerings to facilitate a transition towards more sustainable business models that do not rely on increased growth by merely increasing the sales of products. Seeing that the existing literature on PSS seems to neglect this role of local public authorities and only discusses the role of public institutions from the perspective of legislators and procurers this study has, through its explorative approach, added a contribution to the discussion PSS and the role local public authorities can play in furthering the creation of sustainable PSS solutions. This role of facilitator of trials and enabler of the testing of PSS related business model should be investigated more thoroughly and in a more systematic manner going forward. Three further directions for potential future research are briefly outlined in subsection 6.3.

### 6.1.2. Practical Implications

In order to support the creation of new sustainable PSS solutions in general local public authorities should make increased use of procurement regulations favouring sustainable solutions. However, measures need to be implemented that allow for the tracking of progress of procuring sustainable solutions. In addition new models for public procurement processes need to be developed, such as for example that of “market dialogue” mentioned by HSY, to alleviate the problem of requiring three competing offerings in public procurement regulations. Those requirements can significantly hinder choosing innovative new solutions in situations where no competition is existing yet.



Additionally, local public authorities should continue to take a more active role in furthering the creation of sustainable new services by hosting and coordinating projects and trials that actively seek to test out innovative services and sustainable solutions, especially with a focus on mobility and transportation. In order to have an even higher impact with these projects improvements should be made that make schedules and decision-making-processes more transparent and provide clear contact persons to streamline communication. These improvements would provide great opportunities in jointly developing new innovative service solutions to promote cycling, as there currently appear to be issues when public and private entities are trying to collaborate.

Furthermore, the challenges regarding the increased need for investment needs to be addressed. This challenge exists with all sustainable PSS solutions in general. However, it is even bigger concerning the creation of PSS solutions promoting cycling as the factor of seasonality significantly impacts the potential profitability of such solutions. The question remains which tools could be developed in order to address this increased need for investment, but it appears that public authorities would be well advised to take a role in the development of such tools as time is quickly running out to achieve climate change mitigation goals in time to limit global warming to an average of 1,5°C. As these challenges are particularly big in the context of existing businesses transitioning to new business models to provide sustainable PSS solutions one potential solution could be focusing on the creation of new businesses instead of transitioning existing companies towards more service-based business models. This could for example be done by developing tools to support the funding of start-ups with a clear sustainability agenda. How such tools could look like is beyond the scope of this research and should be the topic of future research.

While strategic goals on national and regional levels are already in place which aim for low carbon transportation, local public authorities also depend on legislative bodies to rather quickly implement legislation that actually helps enforces such strategic goals. Those could for example include vehicular traffic pricing (congestion charging). Without legislation it will remain very hard to implement sustainable solutions that are currently potentially facing economic disadvantages when compared to unsustainable solutions. Restricting the use of private cars or raising the cost of driving through measures such as vehicular traffic pricing not only increases the possibility of reaching climate change mitigation goals in the

field of transportation but also opens up opportunities for innovative new services to become financially viable, even those promoting cycling, which are facing the additional challenge of seasonality. Taxing bike maintenance services at a lower rate to support the upkeep of existing bikes could also be a feasible option. In contrast to supporting the buying of new bikes through one time subsidies, which are increasingly popular in other European countries, or generally lowering the sales tax on (electric) bikes, this could help to promote their actual usage instead of merely their acquisition. At the same time this might stimulate the creation of new jobs in the field of bike servicing, as people might use cheaper maintenance services more frequently.

## 6.2. Limitations

This study was carried out as an explorative case study and thus by its nature the findings are very limited and in no way generalisable on a large scale. They do however provide a starting point for further research to be carried out.

### 6.2.1. Data

With regard to the sample, this study is limited as it only included a small number of interviewees from relevant actors in the Helsinki metropolitan area. In hindsight it could definitely have benefitted from extending the sample to also include further actors from the private sector such as especially investors and entrepreneurs with experience in creating Product-Service Systems of their own. It is assumed that the findings of this study still provide some relevant indications of how public actors could further the creation of sustainable PSS to mitigate climate change but future research could certainly benefit from extending the sample to include further actors to create an even more holistic understanding.

Another limiting factor is that much of the additional data and information produced by e.g. public institutions in Finland is of course in Finnish, which has been limiting for the accessibility of data and public documents. It was assumed at the beginning of the study that much of that data should have been available in Swedish as well, seeing that it is the second official language in Finland. That would have greatly alleviated the language barrier.

### 6.2.2. Language of the Interviews

All interviews for this study were carried out in English. This is a foreign language to all of the interviewees as well as the interviewer. While it provided a chance to better understand the Finnish context and clarify information that was otherwise largely inaccessible to the author of this study this fact also presents a certain source for errors. Concepts that would have been especially difficult to explain might not have been mentioned during the interviews and could thus be missing from the findings. Additionally, different understandings of certain words used might have caused uncertainties in the topics discussed. While this issue certainly exists and the actual impact is hard to estimate it is assumed that for the purpose of the study the findings were not significantly impacted in a negative way as all parties involved appeared to form a common understanding of the topics at hand during the interview process.

### 6.2.3. My Own Involvement

As outlined in the introduction chapter, subsection 1.5.2, I remain personally very tightly connected with the Bikefy concept that was developed in spring 2017 during the Creative Sustainability Capstone course at Aalto University in cooperation with HSY, HSL and the City of Vantaa. Continuing work on that and carrying out two trials in parallel to producing this thesis to evaluate the actual business potential of the concept and its practical feasibility certainly provide a basis for potential bias. As all interviews took place at a time when it was yet unclear how I would personally continue with the development of the concept and none of the trials were confirmed the experience I gathered during the continuation of the process could not have had a significant impact on the process of conducting the interviews. However, due to the increased workload of the first trial and subsequent work to further test the concept the interviews were transcribed and analysed a time when I was already much more involved with the continuation of Bikefy as a potential company. Therefore my personal experience might have had an influence on the perspective I took while coding and analysing the interview transcripts. Though I tried to stay as neutral as possible, I cannot fully rule out a potential impact this might have had. Overall I believe that my practical experience rather positively contributed to forming a better understanding

of the context and the issues different actors are facing when trying to develop innovative new solutions that aim at providing sustainability related benefits.

### 6.3. Future Research

With the implications and limitations presented above there emerge at least three very interesting pathways for future research to be carried out. Firstly, as this study lacked the perspective of investors and entrepreneurs it would be interesting and necessary to create further understanding of the issues these two actors are facing connected to financing sustainable PSS solutions and how they think public authorities could contribute to overcoming potential barriers. Secondly, research should be undertaken that examines whether public authorities can create funding tools that specifically help overcome the challenges of increased needs for investment when creating sustainable PSS solutions to achieve climate change mitigation goals. Thirdly, with many public authorities in the Helsinki metropolitan area currently organising projects to test new innovative services and related business models it would be beneficial to undertake further research that more closely evaluates the suitability of such projects for implementing the services and business models being tested.

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## 8. APPENDIX

### 8.1. Interview Guides

#### 8.1.1. Finnish Ministry of Transport and Communications

1. Which role do you see the LVM in with regard to reaching climate change mitigation goals (especially related to transport)?
2. To which extend is a move towards less carbon emissions a motivation behind the transport code legislation?
3. How could the LVM further a move towards more sustainable mobility? (The fact sheets mention that driving more would actually get cheaper due to termination of the fuel tax.)
4. To which extend would stronger regulation instead of deregulation help reaching global climate change mitigation goals?
5. How could legislation enable Public Transport Operators to develop innovative services on their own, e.g. when the service is not yet offered by an existing business on the market?
6. How will private mobility providers be taxed in comparison to public transport? (HSL is subject to a lower VAT rate than the general rate of 24%)
7. What is considered a motor vehicle?
  - a. How about electric bikes for example?
8. Will the envisioned company only sell usage rights outside of urban areas, or does road usage inside e.g. the Helsinki metropolitan area also fall under this fee?

### 8.1.2. Helsinki Regional Transport Authority HSL

1. How would you describe HSL's role with regard to reaching climate change mitigation goals for the transport sector?
2. What is the Research and Development process for new services at HSL?
3. How would you describe HSL's role in developing services that do not build on pre-existing solutions?
4. Which challenges do you perceive in making public transportation even more environmentally friendly? (e.g. Electric bus routes.)
5. To which extend can HSL itself develop new innovative services compared to having to rely on market offerings?
  - a. (Tendering existing solutions versus Co-Creation of new innovative services?)
6. To which extend would the proposed legislative change (Liikennekari/Transport Code) enable the creation of new innovative services?
7. To which extend is HSL able to influence policy decisions in Helsinki to increase feasibility of new innovative/environmentally friendlier services?

### 8.1.3. Helsinki Region Environmental Services Authority HSY

1. How would you describe HSY's role with regard to reaching climate change mitigation goals?
  - a. With regard to Public Transport?
2. What is the Research and Development process for new solutions at HSY?
3. How would you describe HSY's role in developing services that do not build on pre-existing solutions?
4. Which challenges do you perceive in developing solutions to reach climate change mitigation goals?
5. To which extend can HSY itself develop new innovative services compared to having to rely on market offerings?
  - a. (Tendering existing solutions versus Co-Creation of new innovative services?)
6. To which extend is HSY able to influence policy decisions in Helsinki to increase feasibility of new innovative/environmentally friendlier services?

#### 8.1.4. City of Vantaa

1. What are/have been the main challenges with regard to “Building an ecologically and culturally sustainable city”?
2. To which extend are existing regulations (e.g. required parking spaces) a limitation when it comes to achieving your sustainability goals?
3. One of the stated goals was “creating innovative mobility solutions”. What are/have been the biggest challenges with regard to that?
4. How is the city of Vantaa co-creating innovative mobility solutions with businesses?
5. How would you describe Vantaa’s role in developing services that do not build on pre-existing solutions?
6. To which extend does the existing road infrastructure provide a challenge with regard to developing more sustainable mobility solutions that are less car centric?
7. How does the Aviapolis development project further the development of innovative sustainability oriented mobility services that do not build on pre-existing solutions?

### 8.1.5. Independent Bike Shop

1. HSL's strategic goal is to promote cycling and walking. As a bike shop owner focussing on specialty bikes, to which extend has that become noticeable to you?
2. Have you heard of or participated in any co-creation activities together with HSL or other public authorities in the Helsinki metropolitan area to address the promotion of cycling?
3. Could you describe your experience attempting to collaborate with HSL or other public authorities with regard to promoting cycling?
  - a. (Dutch Embassy)
4. To which extend is there ongoing collaboration with organisations such as Pyöräliito with regard to the promotion of cycling?
5. Which impact do initiatives such as the Self-service station at Kamppi have from your perspective?
6. How would you ideally imagine a collaboration with HSL or other public authorities in the Helsinki metropolitan area to further promote cycling?
7. How do you see efforts of other European cities/countries to promote e.g. cargo bikes by providing one time grants?



### 8.1.6. Bike Distributor

1. How did you experience the process of becoming the operator for the Kamppi Self-Service Station?
2. Which impact do initiatives such as the Self-service station at Kamppi have from your perspective?
3. Could you describe your experience (attempting to) collaborating with HSL or other public authorities with regard to promoting cycling? (Kamppi)
  - a. (Creating Business Models?)
4. Have you participated in any other co-creation activities together with public authorities (e.g. HSL/HSY) in the Helsinki metropolitan area to address the promotion of cycling through new services?
  - a. (Creating Business Models?)
5. Have you heard of any (other) co-creation activities together with public authorities (e.g. HSL/HSY) in the Helsinki metropolitan area to address the promotion of cycling through new services?
6. HSL's strategic goal is to promote cycling and walking. To which extend has that become noticeable to you?
7. How would you ideally imagine a collaboration with HSL or other public authorities in the Helsinki metropolitan area to further promote cycling?
8. How do you experience the role of local governments with regard to promoting sustainable mobility such as cycling?
9. To which extend is there ongoing collaboration with organisations such as Pyöräliito with regard to the promotion of cycling?
10. To which extend do you experience bike manufacturers developing new business models (in cooperation with the public sector)?
  - a. Comparison to City Bike systems?

11. How do you see efforts of other European cities/countries to promote e.g. cargo bikes by providing one time grants?
12. How are your own efforts with regard to starting up e-bike rentals succeeding in promoting sustainable mobility (Cycling)?
13. What were your motivations behind starting this service?

## 8.2. Consent Form

Date: \_\_\_\_\_

Name: \_\_\_\_\_

I, the undersigned, herewith agree that the interview I give within the context of research undertaken in the course CS Capstone at **Aalto University**, Helsinki, in cooperation with the **Helsinki Region Environmental Services Authority (HSY)** and **Helsinki Region Transport (HSL)** may be **recorded** and **transcribed**.

The transcript will be **anonymised** and quotations may be taken from it without mentioning my name or disclosing information that reveals my identity.

The anonymised transcript may be published as appendix to the final report:

Yes

No

This data may also be analysed within the **Master's Thesis project** conducted by **Norbert Schmidt** at the **Aalto School of Business**.

The anonymised transcript may be published as appendix to the Master's thesis:

Yes

No

\_\_\_\_\_

Signature

Codification: \_\_\_\_\_