# Stimulating Sustainable Urban Travel Behavior through Mobility as a Service

*Master's Thesis in the Master's Program Industrial Ecology*

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# Abstract

The purpose of this study is to examine factors and strategies to encourage and stimulate sustainable travel behavior. The research field of so called persuasive strategies is reviewed in the literature, applied to awoke a change in travel behavior, and then reviewed again during interviews with Swedish mobility service providers. The following two research questions steered the work of this study: *What types of strategies exist to incentivize sustainable travel behavior?* and *How are these applied among Swedish mobility service providers?*. This study employs a qualitative approach with mixed methods consisting of a literature review on the topic of persuasive strategies in the context of sustainable mobility, and an interview study conducted with twelve Swedish mobility service providers.

Today's road transport sector gives rise to numerous severe sustainability issues. Utilization of private cars contributes to e.g. pollution, global warming and congestion. It also inflicts negative impacts on human health and socio-economic factors. Further, private car ownership is problematic regarding the inefficient resource use. To facilitate modal shift from private cars, alternative services like public transport, biking, carpools, bikepools etc., must be designed to fulfill the needs of travellers, in order to compete with car ownership. One attempt to do just that is Mobility as a Service, MaaS, offering a seamless combined mobility service, placing the customer needs in focus.

The literature review resulted in an analytical framework consisting of persuasive strategies, framed as *nudges through digital media* and *gamification*, including different persuasive mechanisms. The analytic framework puts sustainability issues in relation to practices aimed to stimulate sustainable travelling. The mobility service providers were highly aware of sustainability issues related to transport, but not as knowledgeable of possible indirect effects from utilization of their own services. Persuasive strategies were not particularly recognized as a way to stimulate sustainable travel behaviors.

Concluding remarks concern conducting long-term pilots to understand the effects of using persuasive strategies, increasing practitioners' knowledge within the field of research. Lastly, the necessity of combined efforts through policy interventions, and practitioner acting in light of research, in order to stimulate sustainable travelling, is emphasized.

**Key words:** Sustainable mobility, travel behavior, transport, persuasive strategies, nudging, gamification, Mobility as a Service, impact categories

# Acknowledgement

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# 1 Introduction

The industrial activities of modern society are causing severe environmental degradation in a wide range of areas, where the transport sector is a large contributor to most of them (IPCC, 2014; World Health Organisation, 2000; Rockström et al., 2009). These areas include for example global warming, human health, acidification, as well as social sustainability aspects connected to transport such as safety, equality and accessibility. When the concentration of cars increase, usually in urban areas, the negative effects accumulate, for example in rush traffic and congestion where the air quality deteriorates (Friedman et al., 2001). Over 72 % of the population in Europe live in urban areas, a number that is rising (IPCC, 2014). This implies challenges as well as opportunities for sustainable transportation (Banister, 2008; Watson, 2009; IPCC, 2014). The decrease in travel distance as cities grow creates opportunities for cycling, walking and accessible public transport. However, urban densification also requires efficient city- and transport planning to avoid a continued car dependency and decentralization of cities (Stradling, 2003; Banister, 2008).

The habitual choice of travelling by car generates large environmental and societal costs as well as worsening conditions of both socio-economic and human health factors (Organisation for Economic Co-operation and Development, 2014). As the sustainability of private cars is being more and more discredited, the option of not taking the car needs to be facilitated through the existence of mobility services and the promotions of such behavior in order to encourage long term change. In this report, focus will be on investigating the mitigation of negative impacts from the transport sector through incentives and persuasive strategies applied by mobility service providers encouraging individuals' to adopt sustainable travel behaviors in urban environments.

*Mobility as a Service* (MaaS) is a user-oriented service, offering access to combination of mobility services, that aims at providing an alternative to car ownership. MaaS has the potential to reduce environmental and societal negative impacts of heavy road traffic in urban areas (Jittrapirom et al., 2017; Sarasini et al., 2017a). The concept is based on flexible multimodal mobility services that combine public transport, car pools, taxi services, bicycle pools and other services, with the purpose of providing new types of transport solutions. By promoting a shift from owning a vehicle to having access to various means of transport, MaaS services have the potential to change the way people travel in urban areas. As MaaS is a rather new concept, referred to as a 'disruptive innovation' (Sarasini et al., 2017a), no clear definition yet exists and it has only been trialled to a fairly low degree, however several pilots are underway across the globe. Adoption of MaaS is thought to bring about a more efficient use of existing resources, mitigation of air pollution and numbers of road-related accidents, but also to result in a sustainable modal shift (Jittrapirom et al., 2017; Sarasini et al., 2017a).

The aim of this study is to investigate different strategies for stimulating and promoting sustainable urban travel behaviors through mobility services. Different categories of strategies will be discussed in relation to how they are defined in the literature, what mechanisms they entail and how they are deployed by Swedish mobility service providers. On the topic of sustainability, the economic dimension will not be considered to a large extent, such as national and global economy, since it has no direct influence on travel behavior. Environmental and social sustainability on the other hand, is directly linked to behavior and mobility. The most considerable part of economy for this study is perhaps the travel cost, which is decisive for how people travel, and will therefore be touched upon. Thus, the economic dimension is not part of our scope.

A literature review of persuasive strategies applied in the context of urban road transport and sustainability issues related to the transport sector will be used to develop an analytical framework upon which an empirical study will be based. The empirical interview study will investigate how existing mobility service providers in Sweden are stimulating sustainable travel behaviors, and what sustainability aspects they aim to mitigate through their service. Semi-structured interviews will be held with mobility service providers operating in Sweden. The geographical limitation assures that the mobility providers are steered by a common regulatory framework and operate within a relatively homogeneous culture with similar mobility patterns and attitudes of users and customers.

This study will focus on mobility of people, not including freight transports. The reason for this

is that personal choice have a more tangible and direct effect of personal transport habits, while freight transport is more related to larger consumer patterns. More specifically; the study will be centered on individual behaviors concerning personal transports. The focus will be on factors that have an affect on personal choice. Further, various mobility service and mobility service provider will be examined based on possible effects on personal transport preferences of customers and users and implications on sustainability.

The two following guiding questions are developed aiming to steer the project work towards a relevant outcome.

- What types of strategies exist to incentivize sustainable travel behavior?

- How are these applied among Swedish mobility service providers?

The structure of this study consists of an explanation of the methodology in the Method section, to introduce theoretical results from the literature search in the literature review section, to present the findings from the empirical interview study in the section Mobility service providers in Sweden, and last to discuss findings and reach conclusions in the sections Discussion and Conclusions. The literature review covers the topic of sustainable road transportation and its implications on social and environmental impact categories and reviews mobility related studies deploying persuasive strategies to influence travel behaviors. Persuasive strategies is another term for nudges; they are developed to purposefully steer behaviors at a desired direction, without coercion or monetary incentives. The interview study investigates what sustainability impact categories the service providers are aware of, and what persuasive strategies they employ in order to stimulate their users' travel behaviors.

## 2 Method

The study utilizes a qualitative mixed method approach, performed in two parts.

### 2.1 Literature review

The first part of the study is a literature review, with the aim to provide a theoretical background for the study, and to serve as an analytical framework for the interview study and analyzing interview findings in relation to implications from theory. The main scientific data base used was Scopus. Scopus is said to be one of the two most utilized databases for scientific research, the other being Web of Science (Chadegani et al., 2013). Eventually, Scopus was judged to be more suitable due to a function allowing searches based on keywords, which was not the case at Web of Science. That function was helpful in making the searches more specific, reducing the number of hits and limited the search result to the most relevant literature for the topic.

The keywords are derived from the purpose of discerning ways of promoting sustainable travel behaviors. Articles found were scanned for terms regarding such tools, and new searches were performed based on these terms. For example, the terms 'persuasion' and 'persuasive strategies' were found this way. The keywords were also formed with the purpose of revealing effects of the transport sector and how these effects are related to the decrease of privately owned conventionally fueled vehicles. The keywords concern the encouragement and promotion of sustainable travel behavior, which revealed strategies of persuasion and various concepts of nudging. Searches were also directed towards sustainable mobility as such, revealing theories of how to achieve a sustainable transport sector. Another area covered by data searches was sustainability issues, for example acidification and global warming, and their connection to the transport sector. In searches a theory, such as *gamification*, was combined with an area of application, such as *mobility*. In the cases when no, or no relevant documents could be found via Scopus, the search engine provided by Chalmers library, Google and Science Direct were used instead. Examples of other combinations of keywords used are for instance:

| Scopus |
| --- |
| sustainable travel AND behavior |
| sustainable mobility AND persuasive OR persuasive technologies |
| Impact categories AND transportation |
| equality AND transport |
| **Other search engines** |
| green defaults |
| environmental factors in the transport sector |
| impact categories transport |

A full list of searches and data bases can be found in Appendix A.

In addition to the structured literature search, snowballing was used as method to find relevant literature. 27% of the total number of literature was retrieved using this method. The snowballing was performed by scanning relevant articles for oft-cited works regarding the subjects of interest. Case studies of previous MaaS initiatives have been studied in order to relate mechanisms used to influence travel behavior to persuasive strategies found in literature. Ten such studies were included in the literature review (see table 1 in section 3.3.1).

| Type of document | Number |
| --- | --- |
| Peer reviewed journal articles | 88 |
| Conference proceedings | 15 |
| Technical reports | 11 |
| Books | 17 |

The literature is put in relation to mobility needs of people; to the possibility of contributing to changed behavior; and to attitudes and values connected to sustainability. This implies that the study is qualitative, in accordance to the description of what a qualitative study is by Ahrne and Svensson (2011) and Creswell (2009). The literature review focus on theories that applies persuasive strategies. What is not considered is the scientific perspectives on persuasion such as behavioral science and psychology, nor *why* these theories are applied. That is outside the scope of the study. Compared to a quantitative study, a qualitative study is not backed up by extensive statistical data (Ahrne and Svensson, 2011) however, the the reliability of a study like this one depends on whether the information collected is trustworthy or not (Eliasson, 2013). The majority of the articles referred to in this study are peer reviewed and published in scientific journals or are reachable at scientific databases, enhancing the validity of the study's content. Due to the approach of using snowballing - searching literature by scanning relevant references and keywords from other scientific paper related to the topic - the literature review might not be exactly replicable.

Literature reviews are called biased by some due to researches choosing what literature body to include (Massaro et al., 2016). As the literature review in this study has been aimed at gaining deeper knowledge of the research subject, it can be argued that it has been performed without any bias. The lack of possibilities to ask questions and the fact that the knowledge will always be secondary are drawbacks of this method. However, to learn from experts with detailed knowledge in their fields is valuable, if not necessary, before embarking on empirical studies in an area.

## 2.2 Interview study

Part two of the study consisted of semi-structured interviews, conducted with Swedish mobility service providers. They were performed in order to investigate what is currently done to promote and enhance sustainable travels, within their services and otherwise, and what sustainability issues the strategies aim at mitigating. The interviewees were chosen with respect to the following criteria, concerning the actors: (1) actors that actively work to develop, enable or run existing mobility services; (2) having the potential to persuade customers or users through their services; (3) the service promotes sustainable travelling by substituting conventionally fueled vehicles and/or private cars.

The choice of using semi-structured interviews can provide answers to both general and specific questions but it also leaves room for interviewees to tell their story, which can enrich the study (Rabionet, 2011). Objectivity of interview data can be debated due to statements made by respondents are required to be controlled and to not be distorted from personal preconceptions. However, when posing the question if interview data is to be trusted as objective, one needs to consider other implications of objectivity such as reflexive objectivity and intersubjectivity, concluding that it is in fact objective (Kvale and Brinkmann, 2014). An important trait of semi-structured interviews is the notion that both respondent and interviewer are affected by each other and the re-

liability will depend on any pre-existing knowledge of the subject and interplay between interviewer and interviewee (Lantz, 2013). According to Kvale and Brinkman (2014), whether or not an interview is reliable depends on if results retrieved from interviews can be reproduced by other researchers, which is something that cannot be guaranteed. Semi-structured interviews allow subjects to elaborate and express their views freely; for these subjects to express themselves in the exact same way again is highly unlikely. The interviews were transcribed and the data was analyzed using codes, so called 'templates' (Miles et al., 2013), trying to discern themes in the data. The overall categories include perceived sustainability, service design, persuasive strategies, future trends and combined mobility, as well as a number of subcategories.

The subject of the study is personal transport and any factor that can stimulate and encourage sustainable travel habits. According to DiCiccio-Bloom and Crabtree (2006), respondents in semi-structured interviews should be similar and have a strong connection to the research question. Even if individuals and their choices is the focus, individual behaviors can be affected by for example using an electric company car at a place of employment. Therefore, mobility services serving mostly organizational clients have been included in the interview study. Below is a list of the respondents included in the interview study and their organizations briefly described. For ethical purposes the respondents and organizations in this study are anonymized, however some may be possible to identify from the following descriptions.

- Service provider 1 (P1) is a station based carpool service exclusively providing electrical cars. 90% of its customers are organizations, and the rest 10% are private customers.

- P2 is a station based carpool, aimed at being a hassle-free alternative to car ownership, substituting shorter trips. A registration fee is required for utilizing the service as well as monthly subscription to one of the four mobility packages. The pricing system is based on variable costs including the number of kilometres driven.

- P3 is a free floating carpool service, which is mainly used for short rides (28-30 minutes in average). A registration fee is required

for utilizing the service. The pricing system is based on the pay as you go concept, but also applies dynamic prices based on the areas where the car is used. Optional monthly subscriptions based on numbers of minutes are available, which are only valid for one month.

- P4 is a pod taxi service, providing electric vehicles classified as mopeds. No registration or subscription options are available. Instead, the pay per use concept is applied, charging per meter driven. Average trips are about 2.1km long, and 30% of trips substitutes taxi rides and 25% of trips substitutes walking. As high as 50% of their users use their service for mainly environmental reasons.

- P5 is a public transport provider, offering trips by boat, tram, train and by bus. The pay per use concept is applied. Optional subscriptions of various time length are available (monthly and yearly for instance). The dynamic pricing is based on a division of geographic zones in which the service is operating. Other mobility offers, departing from the main operations, is an on-demand mobility service offered in more remote areas.

- P6 is a public transport provider, operating mostly in rural areas. Optional subscriptions are available, for instance as monthly and yearly subscriptions. Conducts bicycle campaigns every year, as well as targeting work places to promote employees to develop sustainable travel habits.

- P7 is a company that focus on developing services among public transport providers. The company is owned by 37 different traffic oriented businesses, whom are also customers as the company provides solutions in order to develop their services, ordered by the owners. Its aim is to contribute to a sustainable society through collaborative measures and to facilitate travelling with public transport through increased efficiency and profitability among its clients.

- P8 is a train operator, owned by the Swedish state. The pricing model is based on dynamic prices, and includes both single tickets and offers periodic subscriptions, targeting commuters and company clients. It

populates railways all across Sweden as well as nearby European cities such as Oslo and Copenhagen.

- P9 initiated a mobility service within their operations, as they saw a need among their customer to be mobile without owning a car. As a real estate manager, housing with tenants needing a car occasionally acts as the perfect set up for a carpool service. They are partners with a carpool service provider in order to offer the service to their tenants.

- P10 is a provider of electrical vehicles and a developer of new mobility solutions, aiming to combine shared mobility with the technology of autonomous driving and electrical vehicles. The company representative, focusing on developing solutions superior all other alternatives, predicts mobility of the future to be self-regulating. They aim to provide the same benefits that owning a car currently does and at the same time solve problems connected to car use, such as parked, non-moving cars.

- P11 launched a major pilot project aiming at implementing a MaaS service - a bundle of mobility services provided by one single offering - in the Gothenburg area, combining public transport, taxi and carpool services in order to serve as a substitute for private car ownership.

- P12 launched an app aiming at stimulating sustainable travel behaviors through challenges, rewards, structuring complex choices and social persuasive features. No mobility service as such was offered, however it promoted walking, cycling and public transport.

# 3 Literature review

This report is structured in six sections, of which this is the third. Previous sections consist of an introduction while the second section describes the methods with which this work has been performed. This section will present findings from the literature review, concerning sustainability in the road transport sector. All findings are put in relation to the research questions stated in section 1.

## 3.1 Background

The transport sector contributes to 24 % of total greenhouse gas emissions globally (International Energy Agency, 2017), and urban traffic, which is the focus of this study, constitutes 40 % of total transport emissions (IPCC, 2014). A prerequisite for reaching sustainability goals and targets, locally and globally, is mitigation of the negative impacts caused by the transport sector. Implications of road traffic include noise, congestion and car accidents, and inefficient use of resources. Standard occupancy of a car in central Gothenburg is 1,29 people (Göteborgs stad, 2012), and the averag car is parked around 90% of the its use phase.

Attitudes towards sustainability as well as the level of income influence the choice of transport, according to OECD report (2014). The benefits from reducing car usage in cities are numerous, however research suggests that such insights themselves are not not enough to influence the individual transport choice (Sonchor et al., 2015; Organisation for Economic Co-operation and Development, 2014). Regardless of the knowledge about the negative impact caused by conventional car use, people are not giving up on their private cars. One reason might be that existing infrastructure is built for cars and other motor driven vehicles (Organisation for Economic Co-operation and Development, 2014), while it may also depend on the idea of the private car as being convenient, flexible and offering both status and privacy (Bergstad et al., 2011) cited by (Redman et al., 2013).

Striving for sustainable mobility should consider a reduced need, and thus demand, for private cars as a main objective according to (Batterbury, 2003) cited by Redman et al. (2013). Similarly, the promotion of modal shifts, reducing travel times and facilitating behavioral changes should be considered crucial factors (Banister, 2008), since the extent to which privately owned cars are used suppresses "sustainable levels of economic performance, social welfare and environmental resilience" (Redman et al., 2013). However, Banister (2008) points out that it is not about introducing punitive measures, but rather "to design cities of such quality and at a suitable scale that people would not need to have a car". One may also reason that provision of alternative services are also important, and that the service itself may constitute a motivation for changed travel behaviors.

The question is how such a transition would be realized. Scanning literature, various approaches to promoting and increasing the use of sustainable transport modes were found. Some of these approaches supported political interventions (Banister, 2008; Cairns et al., 2008) and behavioral change of individual's in relation to mobility services (Klecha and Gianni, 2017), while other approaches focused on the combination of policy measures and the focus on individuals, as that will be necessary for bringing about a change regarding the way people travel (Sunstein and Thaler, 2003; Barr and Prillwitz, 2013).

This study is carried out based on the assumption that it is the choices of individuals that may produce a change. This approach may be an element in a larger transition towards a sustainable transport sector. Thus, most of the literature review is focused on how to stimulate individual behavior change. Travellers in urban environments today have plenty of options to choose between for their daily trips. The problem is not having options but rather choosing the best alternative - the more options there are, the more complex is the process of screening the alternatives (Hilgert et al., 2016). Choices can be affected by regulations and availability with regards to infrastructure, but it may also depend on available alternatives fulfilling the needs of the travellers, the same way as owning a car does.

Some authors are critical to the approach focusing only on individual behavioral change, suggesting it fails to acknowledge the responsibility of policymakers and politicians (Barr and Prillwitz, 2013; Hall, 2013). However the most common view is that it is a valid approach of accomplishing change (Fogg, 2003; Sunstein and Thaler, 2003; Lehner et al., 2016; Bothos et al., 2014). Existing infrastructure can be seen as a barrier for modal shift, implying that policymakers can take action by introducing congestion charges and making changes in the existing infrastructure, which will allow alternative means of transport to use the space (Cairns et al., 2008; Organisation for Economic Co-operation and Development, 2014). Since this type of intervention, also called 'hard measures', often is met with resistance it may be appropriate to also focus on 'soft measures'. Soft measures focus on individual motivations by providing information and promoting awareness of sustainability issues. In order to decrease reluctance against hard measures aimed at promoting

sustainable travelling, soft measures can be intricuced at the same times, for example; free bus tickets can be given citizens combined with information campaigns about sustainability issues or the environmental or economic benefits gained from using public transport (Henriksson et al., 2011; Cairns et al., 2008; Karlsson et al., 2016). Cairns et al. (2008) claims that the approach of including both hard and soft measures has a good potential of reducing traffic, in terms of congestion, single ride vehicles and promoting public transit. Estimates have shown that such interventions have the potential to decrease traffic levels by 10 to 15% (Cairns et al., 2008). Redman et al. (2013) have identified seven factors that transport services, in their case PT, must fulfill in order to capture car owners. The quality attributes are said to be reliability, frequency, price, speed, access, comfort and convenience. The study interpreted price and frequency as two highly important factors needed to facilitate a transit from car to PT, but without the other quality attributes, the effect would not last in the long term, the main reason being that owning a car already offers most of these attributes (Redman et al., 2013).

The development of new mobility solutions opens up for alternative ways of travelling that can provide incentives for people to choose other modes of transport or other travel routes for their daily trips. Such initiatives have been developed attempting to facilitate sustainable travelling by increasing awareness of the impact that different means of transportation have on the environment, while suggesting alternative options and in that way influence travellers' decisions (Bothos et al., 2014; Jittrapirom et al., 2017).

## 3.2 Sustainable mobility

One common definition of sustainable development is by Gro Harlem Brundtland (United Nations, 1987), where it is defined as "... it [sustainabile development] meets the need of the present without compromising the ability of future generations to meet their own needs." 'Needs' are recognized as goals related to economic growth, social well-being and ecological and environmental health (Goldman and Gorham, 2006). The transport sector is consuming non-renewable resources and causing harms to the environment. These practices can be viewed as interfering with future generations' ability to meet their needs, hence

not being sustainable according to the Brundt-land definition. Environmental issues of alarming urgency have been raised (Rockström et al., 2009) and a significant part of the environmental damage caused by human activities stem from the transportation sector (IPCC, 2014). When measuring environmental degradation inflicted by the transport sector, most often only emissions into air are considered, for example particles and green house gas emissions (Swedish Environmental Protection Agency, 2002). However, the transport sector is effecting the environment in numerous ways (Gössling, 2016; Swedish Environmental Protection Agency, 2002), threatening both ecological, social and economical sustainability. In order to give a wider picture of what impact transport has on nature and human societies, this report has used impact categories to describe the various detrimental effects. The purpose of the categories is to summarize the areas that are effected by the transportation sector and provide brief descriptions of the mechanisms behind.

*Land use:* Roads and land traffic cause land use change that can have great affects on biodiversity, with road fragmentation causing varying degrees of negative effects depending on the size of the integral land (Swedish Environmental Protection Agency, 2002). About 0,01% of Swedish land area and 0,02% of the Västra Götaland region consists of paved roads (Statistiska Centralbyrån, 2010), and only around 0,03% of total roads are bicycle paths (Mattson et al., 2014). The average occupancy in one car driving in Gothenburg is 1,29 people (Göteborgs stad, 2012).

*Global warming:* 35% of Swedish carbon dioxide emissions and 14% of greenhouse gas emissions globally come from the transportation sector (Swedish Environmental Protection Agency, 2002; IPCC, 2014). Warming climate is threatening ecosystems as well as human communities, due to rising sea levels and melting of the sea ice. Emissions of anthropogenic carbon dioxide causes the acidification of oceans which has severe impacts on key marine organisms such as corals and plankton (Orr et al., 2005; Doney et al., 2009).

*Human health:* Tropospheric ozone is formed by nitrogen oxides (NOx) and volatile organic compounds (VOC), most notable hydrocarbons, reacting together with sunlight forming ozone and other oxidants (Swedish Environmental Protection Agency, 2002). Particulate air pollution and the existence of tropospheric ozone are connected to elevated mortality rates and are suspected carcinogenics (Jerrett et al., 2005; Pope et al., 1995). As much as 3% of all deaths in Europe are estimated to be caused by traffic-related air pollution (Organisation for Economic Co-operation and Development, 2014). The transport sector is the biggest contributor globally of both nitrogen oxides and volatile organic compounds (Swedish Environmental Protection Agency, 2002).

*Acidification:* The fall out of acidifying agents caused by emissions of nitrogen oxides (NOx) and sulphur dioxides (SO2) deteriorates conditions for plant growth and, in case of leakage to bodies of water, inhibits fish's capacity to reproduce and ultimately their oxygen uptake (Baker and Schofield, 1982; Driscoll et al., 2003). Acid soils also have detrimental effects on ecosystems and biodiversity (Bobbink et al., 1998; Driscoll et al., 2003). A significant part of the nitrogen oxides emitted is traced back to the transportation sector (Swedish Environmental Protection Agency, 2002).

*Accessibility:* Accessibility is defined by Farrington and Farrington (2005) as a prerequisite for social inclusion, where social inclusion is described as the opportunity for people to participate in society. Bertolini et al. (2005) describes it as "the number and diversity of places of activity that can be reached within a given travel time and/or cost", based on the assumptions that (1) people travel for other reasons than the traveling in itself (working, shopping, visiting family etc.), (2) that people want to have a wide range of modes to choose from, and (3) that travel cost and time seem to limit the number of possible transport modes to choose from. Accessibility is related to transportation as well as other factors such as land use, city planning and infrastructure (Curtis and Scheurer, 2010). Accessibility is not to be mistaken for access to transport. Yet, the terms are connected, as access to transport can affect the level of accessibility. For example, access to public transport is decided by the frequency of which it is provided and to what cost is is offered (Farrington and Farrington, 2005), as well as if there are seats for wheelchairs and strollers. Access to transport is also influenced by factors such as individuals' income, gender and physical skills, to mention some (Farrington and Farrington, 2005) Considering the example of public transport, offered at a high level of frequency, the accessibility

might still be insufficient due to lack of bus stops in areas where the mobility demand is high.

*Road safety:* Road safety includes safety against accidents, such as injuries and deaths, (World Health Organizaion, 2015; Mihyeon Jeon et al., 2006; Haque et al., 2013) as well as safety against crime (Haque et al., 2013). Among the UN Sustainable Developments Goals a 50% reduction of the global number of injuries and deaths caused by road traffic, by 2020 (World Health Organizaion, 2015) is included and a similar goal is adopted by the Swedish government Government Offices of Sweden (2016) aiming at reduce the deaths in traffic by half and reduce injuries by 25%, in 2020. The relevance of the goal can be understood from statistics, year 2012, showing that road traffic is one of the main provocation of deaths and injuries for people in the age of 15 to 29 (World Health Organizaion, 2015). Statistics Sweden present data from 2012 showing that cars are involved in severe accidents in 77% of the cases, while pedestrians and bicyclists are involved in 52% and 10% of the cases respectively (Trafikanalys, 2012). Among the exposed groups of road users are pedestrians, motorcyclists and bicyclists (World Health Organizaion, 2015; Haque et al., 2013; Schepers and Heinen, 2013).

Safety measures can be reduced speed and cautious urban planning to avoid cyclists and pedestrians having to negotiate their safety (World Health Organizaion, 2015). Safety in road traffic may thus affect the level of sustainability - the higher the safety is the more positive effect it will have on national economy, human health, and environmental degradation (World Health Organizaion, 2015; Haque et al., 2013; May et al., 2008). Regarding safety against crime, a big concern is perceived safety. It is the perception of safety that will determine the reliability of the PT system for instance (Haque et al., 2013), and the feeling of safety is the primary factor affecting whether a person will choose to walk or not, which also depends on feasibility and convenience (Alfonzo, 2005). Among the most common crimes connected to transportation is intoxication, vandalism and physical and verbal threats (Loukaitou-sideris, 1999). Studies have shown that women, to a higher degree than men, is more likely to feel unsafe in public spaces, such as transit environments (Yavuz and Welch, 2010). According to Warr (1984) the fear of crimes in general may be derived from females' fear for sexual harassment.

However, there are few studies focusing on men's perception of safety in public spaces and in public transport (Yavuz and Welch, 2010), but one that does suggests that men are concerned about unfamiliar surroundings as well as confrontations in public spaces (Day et al., 2003).

*Equality:* The conditions experienced by pedestrians and cyclists in urban areas with dense traffic has been described by Gössling (2016) and Mullen et al. (2014) as inequality and social injustice. Due to their unprotectedness in traffic, they suffer the worst consequences in collisions with other road users (European Comission, 2015). 26% of all road traffic deaths are pedestrians and cyclists, and risks are highest where bicycle lanes and car lanes are not separated (World Health Organizaion, 2015; European Comission, 2015). Cyclists and pedestrians are also subject to negative effects such as asthma and lowered life expectancy due to emissions caused by road traffic, something that drivers themselves are protected from (World Health Organizaion, 2015; Gössling, 2016).

Children living near roads with heavy traffic are 50% more likely to suffer respiratory decease compared to their peers (World Health Organisation, 2000). Another aspects of social (in) equality related to transport worth mentioning is the fact that 46% of motorized vehicles are owned by high income population, however they only represents 10% of deaths in traffic (World Health Organizaion, 2015). Low income population owns 1% of all motorized vehicles, but represents 16% of all traffic deaths (World Health Organizaion, 2015).

### 3.2.1   Mobility as a Service

The concept of Mobility as a Service (MaaS) is a user-oriented service with the goal of being a flexible alternative to private ownership of a vehicle providing "seamless door-to-door mobility" (Jittrapirom et al., 2017). Embedded deep in the MaaS concept is user centrism and a focus on individuals, as the service provided needs to be tailored to fit each user segment and their needs (Sarasini et al., 2017a). The MaaS concept is thought to be context specific; different prerequisites in cities, in terms of city planning and operating services, one model of MaaS would probably not fit in all urban areas. Further, factors such as availability of public transport, the sufficiency of the infrastructure (favoring only cars,

or benefiting other means of transport), and general attitudes of the population, have an impact on how the MaaS service will be designed.

Before going deeper into how behavioral change can be stimulated, the concept of MaaS will be further presented. From literature studies, it is seen that there is no explicit definition of what MaaS is, and as Sarasini et al. (2017a) points out, it might not be wise to define yet, due to its early stage of development. Among the explanations of MaaS it can be understood as a combination of "different types of mobility services as part of a single, seamless offering made available to users via subscription-based smartphone applications" (Sarasini et al., 2017a).

It is also stated that MaaS is seen as a key part in developing models for smart cities. The realization of smart cities will require the current transport system to change. Rather than focusing on mobility as the physical infrastructure and vehicles, the focus should be on the function of the urban transport system and the services that may be provided. The role of digital technology is emphasized as a significant asset for managing the communication between providers and users (Nempanu Florin et al., 2016). Important to note though, is that MaaS is not an artefactual technology per se but that ICT technology plays a key enabling role in the provision of the service.

One of the core characteristics of MaaS is the involvement of multiple actors, and most often in cross-sectoral collaborations, where many of the actors are not accustomed to working together (Sarasini et al., 2017a; Jittrapirom et al., 2017). Examples of typical stakeholders include transport operators, data providers, technical backend and IT providers, ICT infrastructure, insurance companies, regulatory organizations, universities and research institutions, and customers. (Kamargianni and Matyas, 2017).

Due to the novelty of MaaS, there is no answer of what MaaS actually is nor what outcomes that can be expected (Sochor et al., 2017; Sarasini et al., 2017a). To deal with this uncertainty and allow for flexibility and interchangeability Sochor et al., (2017) have developed a topological approach describing the level of integration of mobility service. The levels range from 0 to 4, where level 0 describes completely segmented mobility services with no integration. Mobility services at a level 0 is the status quo in many cities, where

services operate in isolation and compete against each other. A level 1 mobility service provides integrated information about multimodal travel routes and assists the user in the choice of transport mode. Google is one example providing level 1 service. Connecting the travel planner with a booking and payment system, operating in the very same application, the service reaches level 2 of the MaaS topology. Attracting private car owners will however require more than a level 2 service. Thus, integrating a bundle of mobility services in a subscription based seamless offer, possibly fulfilling the travel needs of the users represents a level 3 service (Sochor et al., 2017; Sarasini et al., 2017a). Finally, level 4 also integrates societal goals, meaning sustainability of the services can be influenced on an institutional level (Sochor et al., 2017).



Figure 1: Topology describing the different levels of integration of mobility services (Sochor et al., 2017).

## 3.3 Persuasion through mobility services

This section will present theory on on persuasive approaches focused on mobility and travel behaviors in order to answer the research question of what type of strategies exist to incentivize sustainable travel behavior. Important to notice is that an integrated MaaS service itself might be a motivation for changed travel habits, given that flexibility, affordability and convenience are provided to the users. However, since these attributes depends on sustainable modal shifts - from cars to public transport, biking or walking (Karlsson et al., 2016) - the sustainability focus is crucial since simply providing the service is no guaran-

tee for sustainable travelling. Yet, these features have been identified as crucial for the user satisfaction and the attractiveness of the service (Karlsson et al., 2016; Sochor et al., 2017; Sarasini et al., 2017b). This section will take on the focus of persuasion through ICT platforms since ICT has a significant role in MaaS, meaning that mobile applications in addition could be used for persuasion, in order to encourage continuous usage of the application. Another reason is that most literature dealt with uses persuasive technology to affect participants. Consequentially the focus of persuasion will differ between the service and the ICT platform - persuasion through the mobility service is directed towards all potential users while persuasion through an app is directed towards those who have already decided to use the service.

Specific measures of persuasion are reviewed, focusing on mobility contexts and urban travel behavior. The research field of persuasive strategies has been screened and two main categories were identified, as follows; *nudges via digital media* and *gamification*. These strategies are divided into six categories, each including a set of mechanisms; *positive incentives and accountability*, *likeability and attractiveness*, *structuring of complex choices*, *social persuasive features*, *green defaults* and persuasion through *pricing*. The mechanisms can be applied to digital media or smartphone applications with the purpose of being persuasive. Similarities between mechanisms used in nudging and mechanisms used in gamification have been noticed, entailing that gamification will be considered as a sort of nudge in this study, even though

they are described in different sections (3.3.2 and 3.3.1).
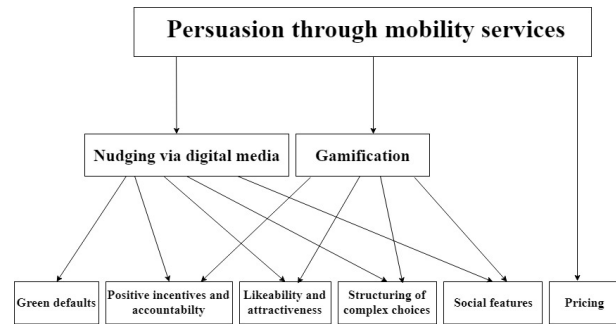


Figure 2: Explains the relationship between the persuasion strategies reviewed.

Figure 2 further clarifies the connections of the persuasion strategies studied in this chapter. As can be detected form the figure, gamification contains several persuasive mechanisms (nudging elements) described in section 3.3.1.

Again, gamification is viewed as a nudge in this study, the reason being that the mechanisms used in gamification shares great similarities to those used in nudging. What is parting the two strategies is mainly the practitioners definition of the strategy aimed for persuasion. However, mechanisms used in gamification, also mentioned as gaming elements, especially encourage to competition and obtain rewards, while nudging is not necessarily focused on the game experience. These interconnections can be seen in Figure 2. A summary of reviewed studies, what strategies they employed as well as reported outcomes can be viewed in table 1.

Table 1: Briefly summarizes the studies viewed in section 3.

| Author(s) | Type of study | Strategies employed | Reported outcomes |
|---|---|---|---|
| Jylhä et al. (2013) | Pilot study aimed at promoting sustainable multimodal travelling. Gamified app with automatic journey tracking and motivating challenges. (Topology level 1. Helsinki. 4 weeks. 12 participants). | Individual competition. Self-monitoring. Tailoring. Goal-setting. Rewards. | Improved awareness of the issue, motivation to strive for reduced emissions and feelings of guilt. 9 - 19 out of 149 challenges completed. 78 - 98% completion rate of challenges. Requests from participants: competition with others and personalization. |

| | | | |
|---|---|---|---|
| Wunsch et al. (2015) | Aimed at increasing bike usage, participants recieved an email each night with details of performance and current score. (Topology level 0. Cambridge/Boston, Massachusetts. 4 weeks. 44 participants). | Triggering, recognition, comparison, cooperation, competition and challenges. (Mainly social features and accountability and positive incentives). | A 13,5% increase in bike usage compared to the control group. |
| Gabrielli and Maimone (2013), Gabrielli et al. (2013) | The app SUPERHUB is an app where participants logged their travel data and were subject to persuasive strategies meant to stimulate sustainable travel behavior. (Topology level 1. Trento. 1 months. 8 participants). | Goal setting, self-monitoring, rewards (personal facebook messages sent to participants) and sharing (social facilitation) | Positive outcome; 14% increase in sustainable travel modes. Most enjoyed and used features was goal setting and self monitoring, and least enjoyed was the rewards. |
| Sochor et al. (2014; 2015) | The UbiGo mobile application is a "broker of transport", providing users with a smorgasbord of transport modes, aiming at reducing the need to own a car. (Topology level 3. Gothenburg. 5 months. 173 adults and 22 children). | Rewards (users earned eco-points which could be exchanged for goods, users also benefited from reduced prices and enlarged zones in public transport). | At the end of the field operational test, 97% of participants wanted to keep using the inter-modal transport service, 93% were satisfied with their travel situation and 93% would recommend the service to others. A 50% decrease in private car use was noted in at the end of the study. 151 out of 173 adults finished all three evaluations, due to the quality of the service. |
| Bothos et al. (2014) | A trial, testing the app PEACOX , investigating persuasive strategies to promote sustainable travel. (Topology level 1. Vienna. 8 weeks, 24 participants). | Reduction, Tailoring, Tunneling, Cause-and-Effect Simulation, Suggestion. | Comparability of different routes was an appreciated feature, making car drivers surprised and guilty over their emission rate compared to public transport. The findings suggests that social and habitual car dependency prevents any long term change. |

| | | | |
|---|---|---|---|
| Bothos et al. (2015) | A trial, testing a smartphone app, PEACOX, applying suggestion as a persuasive strategy in order to stimulate sustainable choice of transportation mode. (Topology level 1. Vienna. 1 month, 28 participants). | Suggestion and Defaults - filtering travel options based on user preference, contextual factors, utility and $CO_2$ emissions using defaults settings to show sustainable options at the top. | Users expressed appreciation of the list of options being easily comparable. No long term change was detected however, and findings suggest that longer studies are needed in order to detect longitudinal change of travel behavior. |
| Froelich et al. (2009) | The Ubigreen mobile application trial examined the effect of visual cues on travel behavior, using an interactive screen where sustainable travel made positive changes (trees growing more leaves and polar bears obtaining more ice.) (Topology level 1. Seattle and Pittsburgh. 1-4 weeks. 14 participants). | Visual cues, gaming elements. | Participants were positive towards the app, perceiving it as a game and referring to scores and levels. They also found it visually pleasing. However, due to the short trial duration, any behavioral changes could be assigned the novelty effect. |
| Hu et al., (2015) | Metropia - Pilot study in USA. App using behavioral economics and gamification mechanisms to decrease $CO_2$ emissions, achieve an even traffic flow and to make travel flexible and time efficient. Provide incentives for off-peak-hours travelling and choosing sustainable transport modes. Non-divers user group. (Topology level 0. Los Angeles. 10 weeks. 36 participants). | Visual cues, gaming elements Rewards, Tailoring, Personalization. | Implemented system. 60% of all travels changed departure time. 51% of all travels took alternative routes. 35% of all travels "changed both departure time and route choice". |

| Kazhamiakin et al. (2015) | Gamified mobile app aimed at incentivize a voluntary sustainable travel behavior. The study was conducted within the scope for the STREETLIFE EU Project. (Topology level 1. Rovereto. 5 weeks. 40 participants.) | Personalization, Tailoring, Goal-setting, Rewards. | Car trips went from 34,8% to 16,9%; Use of the bike sharing service increased from 11,3% to 21,6%; Share of sustainable routes suggested by the application increased from 42,7% to 60,2%. Greater reliance on the app-based mobility service. |
|---|---|---|---|
| Gabrielli et al., (2014) | Pilot study using a mobile app for persuasion of sustainable mobility. (Topology level 1. Barcelona, Milan and Helsinki. 3 weeks. 471 participants). | Goal setting, Rewards, Self-reporting, Tailoring. | High drop-out rate (65 out of 471 participants stayed throughout the pilot study) and thus no conclusion about CO2 emission can be made. Participants requested comparison with others in their social network. |

### 3.3.1 Nudging via digital media

Nudging is a concept which definition is the question of some controversy (Schubert, 2017; Hall, 2013) and this paper adopts the oft used definition of Thaler and Sunstein (2008), which describes a nudge as purposeful changes of the choice architecture in order to steer behaviors in a certain direction, without involving any monetary incentives or coercion. As described by Thaler and Sunstein (2008), the *choice architecture* is the context or environment in which choices are made. For simpler choices, the advantages and disadvantages of the different alternatives are clear and choices can be made without guidance. However, many times there is an overload of information which will lead to an oversimplification and possible misinterpretation of the existing information, as well as electing a sub-optimal option (Thaler and Sunstein, 2008; Thaler et al., 2014; Hall, 2013). The concept of choice architecture can also be widened to include physical aspects (Hall, 2013). For example the decision whether or not to take the car to work does partly rely on norms and social perception; it also depends on the existence of a well-functioning bicycle paths and if the bus stop is located within walking distance. Tools for influencing the choice architecture include defaults, reminders and suggestions regarding certain behaviors, highlighting social factors and norms and using framing and simplification of information. (Thaler and Sunstein, 2008; Lehner et al., 2016; Schubert, 2017).

One area where nudges are largely applied is health. For example the effects of placing healthy snacks near the counter in grocery stores (van Kleef et al., 2012), how menu design can affect amount of vegetarian dishes purchased (Bacon and Krpan, 2018), how nudging can effect the choice of eating whole wheat instead of white bread (van Kleef et al., 2018) or having pictures of sick people on cigarette packaging. Studies have shown nudging to be efficient in a number of different contexts (Pichert and Katsikopoulos, 2008; Ariely et al., 2006; van Kleef et al., 2018; Gabrielli and Maimone, 2013), however it has also been a subject of critique. Critics argue that nudging as a tool for societal change is not as easily predictable as it was first assumed, therefore not able to tackle complex and global issues such as climate change (Hall, 2013).

Nudging has been criticized for shifting the responsibility of making the 'right', sustainable choices from authorities to individuals. Thus, overlooking the paradigms and regimes that entail underlying socio-cultural issues, utilization of nudging has a tendency to make policy in-

struments and regulatory measures seem redundant (Schubert, 2017; Barr and Prillwitz, 2013). Despite of this, a study by Reisch et al (2017) shows that the majority of europeans in six countries (Denmark, Hungary, Italy, France, Germany and the UK) are positive towards the use of nudges.

Behavioral change support systems or *persuasive technologies* are methods of changing undesired behaviors or attitudes through specific features, often embedded in mobile applications (Fogg, 2003). They are a sub-category of nudges characterized as behavioral interventions performed through the mediums of computers or smart phones. Nudges in the shape of persuasive technologies are suited to use when pursuing the goal of a sustainable transport sector, influencing users' travel behavior towards a 'greener' mode of transport (Bothos et al., 2014, 2015; Gossling and Stefan, 2018). When used in the context of mobility, a variety of different persuasive strategies are applied in order to change commuter behavior (Lehner et al., 2016). Sochor et al. (2014) suggests that environmental friendliness is viewed as a bonus as opposed to a criterion for choosing transportation mode, and results from (Froehlich et al., 2009) showed that only 19% of participants in the study viewed sustainability as top three criteria when deciding how to travel. These findings suggests that the knowledge of the environmental damage being caused by a certain transport option alone is not enough to change travel habits. The following persuasion strategies are the ones most frequently mentioned in the literature on persuasive technologies in mobility contexts. They are divided into five categories, where each category supports different functions aiding the overall persuasive ability of the technology or system.

#### 3.3.1.1 Positive incentives and accountability

Positive incentives as motivation for engaging in certain behaviors and the possibility to set personalized goals and track progress in relation to set goals are important persuasive strategies. Reminding users of their goals and rewarding them when reaching said goals encourage consistency and lead to long-term behavioral change. The following strategies are found frequently in behavioral change studies applied in the area of urban mobility, and are derived from the works of Fogg (2003) and Oinas-Kukkonen and Harjumaa (2009):

- *Goal setting:* Goals in relation to desired performance level assist in measuring short term success and continuously motivate users in their progress.

- *Self monitoring:* Serves to keep track of progress and behavior, as well as providing feedback on emissions caused by choices made by the user.

- *Rewards:* This feature can refer to positive feedback or messages when users reach certain sustainability related transportation goals.

The importance of goal setting as a persuasive strategy is illustrated in a study where a mobile application for supporting and promoting green travel was tested, where 19% of participants rated environmental friendliness as top-three criteria when deciding mode of transport, but 72% stated that they would be willing to set goals for them to travel more eco-friendly (Froehlich et al., 2009). Feedback from participants in another study investigating how to promote sustainable mobility shows it was one of the most used and enjoyed features of the application (Gabrielli and Maimone, 2013). In relation to the set sustainability goals, self evaluation and feedback from week to week, tracking progress in relation to the goals is an desired feature for users of such mobility apps (Froehlich et al., 2009; Gabrielli and Maimone, 2013; Wunsch et al., 2015)

There are mixed results of rewards being efficient or not when applied in behavioral change systems. In a study aimed at increasing biking, being rewarded points together with competitions, comparison and cooperation contributed to a 13,5% increase in biking compared to the control group (Wunsch et al., 2015). In the pilot study of the MatkaHupi journey planner, where persuasive strategies were applied to stimulate sustainable travel choices, results suggest that the set of challenges incorporated in the application was successful (Jylhä et al., 2013).

However, other studies suggests that they are in fact a minor incentive when influencing travel behavior, for example Sochor et al. (2014) and Hjalmarsson-Jordanius and van Amelsfort (2017). In the UbiGo field operational trial, ecopoints and premiums could be earned by travelling more sustainable, excluding walking or cycling on a personal bike (only using transportation modes included in the UbiGo service) (Sonchor et al.,

2015). The study concludes that what really mattered in stimulating behavioral changes was the practicality of the service; neither the environmental benefits nor the collected eco-points had any tangible effect on participants.

Rewards and other positive incentives in the promotion of sustainable travel was investigated in the *Res SMART Tillsammans* campaign, and the app *SMARTiSverige* (Hjalmarsson-Jordenius and van Amelsfort, 2017). The study shows an effect of the rewards and positive incentives, but not as great as expected. The hurdle of obtaining a critical amount of users before challenges and rewards become efficient in urban mobility applications has been stressed by Hjalmarsson and van Amelsfort (2016).

**3.3.1.2 Likeability and attractiveness**
This category of persuasive strategies consists of system traits that will build trust and liking, eventually establishing a user-system relationship, making the user more accessible to persuasion by the system. These strategies are not of persuasive character as such, however they aid other persuasive strategies. They also possess social attributes, not user-user but rather system-user. Fogg (2003) describes the human tendency to respond to social cues delivered by an inanimate object the same way as to those delivered by living beings and identifies five social cues that will trigger social responses.

*Physical cues* refer to the human tendency to follow or be persuaded by an attractive person rather than someone unattractive (Messner et al., 2008), which applies to inanimate objects as well (Fogg, 2003). This suggest that an appealing design will be more persuasive than an unappealing. The second cue is *psycological cue*, based on the fact that similarity and self-mirroring will increase positive feelings as well as the chance of persuasion. *Language* is the third cue and is favourably used to praise and flatter users (Chan and Sengupta, 2010), as this seem to have a direct effect on attitude and behavior (Fogg, 2003).

The fourth type of cues is *social dynamics*, promoting the establishment of a relationship and continuous interaction between the user and the system. If there is an existing relationship, persuasion will be more likely to occur. The fifth cue is *social roles*, where the system may convey certain social roles such as an authority, a friend or an opponent; the role should be based on individual circumstances or it might undermine trust as oppose to build it (Fogg, 2003). A study examining computer-human relationships gave two teams problems they were to solve with the help of a computer (Nass et al., 1996). To one team, the computer was refered to as being a teammate, while the other team got no such information. The team with the teammate-computer perceived it as being smarter, more credible as well as more likeable; all features which will aid persuasion (Nass et al., 1996; Fogg, 2003).

Oinas-Kukkonen and Harjumaa (2009), based on the work of Fogg (2003), identifies a category of strategies they call *system credibility support*, where focus is on the information provided by the system to be trustworthy, easily verifiable and presented with authority. Strategies more related to the social role and interaction are found under their category *dialogue support* (Oinas-Kukkonen and Harjumaa, 2009). The following strategies to increase attractiveness and liking of the persuasive system are adapted from the works of Fogg (2003) and Oinas-Kukkonen and Harjumaa (2009):

- *Expertise:* system provides information expressing knowledge, experience and expertise within the area in question.

- *Surface credibility:* users first impression of the system is important; system should appear competent at look and feel.

- *Real-world feel:* transparency regarding the organisation and people behind the content and services.

- *Authority:* if the system acts with authority, it is more likely to have persuasive effects on users. This can be done by referring to the governmental transport agency or other organs of authority.

- *Third-party endorsement:* the system should refer to well known endorsement, ensuring users that their purchases are safe. This can be done by certifications and labels.

- *Verifiability:* the system benefits from providing information that can easily be verified through outside sources.

- *Liking:* Visual appeal is important in aiding persuasion; users that perceive the system as attractive are more easily persuaded.

- *Social role:* in user communications, a sys-

tem might adopt a social role, where user perception is that of talking to a "real" person. One example is virtual personal health specialists interacting with users in an E-health application (Silva et al., 2006).

- *Similarity:* users are more likely to respond positively to something that reminds them of themselves or someone they know. If the system design can replicate users in some meaningful way, it has a greater chance of successful persuasion.

Due to strategies increasing likeability and attractiveness are aiding strategies and indirectly persuasive, most literature do not discuss their application specifically. However, they were most likely applied when developing the behavioral change support systems described in the viewed studies.

**3.3.1.3 Structuring complex choices** Upon having to make complex choices, where alternatives are abundant or information is to detailed and vast, users need help recognizing the alternatives that best fit in with their preferences, and avoiding the use of over-simplification as well as applying predefined levels of attributes (Bothos et al., 2015; Thaler and Sunstein, 2008). It is also a method of facilitating comparison between different alternatives, for example different routes and transportation modes. (Bothos et al., 2014). The strategies of structuring complex choices listed below are taken from the work of Oinas-Kukkonen and Harjumaa (2009) and Fogg (2003).

- *Reduction:* Complex choices and options of transport are condensed down to a few meaningful alternatives, and will help users to perform the target behavior.

- *Tunneling:* Tunneling can be a wizard that lets the user quickly search for transportation modes to reach a certain target location, guiding the user through the process and thus allowing for persuasion along the way.

- *Tailoring:* Based on user preferences the app can provide user-specific data and route suggestions, further reducing the level of complexity and taking user's needs and interests into account.

- *Personalization:* For example route planners remembering past user preferences, grading

options with different level of salience.

- *Suggestions:* System generated suggestions, personalized messages, where users are encouraged to use an environmentally friendly mode of transport.

- *Simulation:* Simulation can mean to use $CO_2$ emissions modeling to calculate and present expected $CO_2$ emissions caused by each route in the route planner, or other cause-effect information about user choices.

Transparent comparability of routes in order to make the advantages and disadvantages of each transport mode clear to the user is a common feature in mobility apps, and enables users to compare factors such as time, distance, cost and $CO_2$ emissions of different routes (Magliocchetti et al., 2011). Effects of added comparability are for example that users driving a car express surprise, guilt and even schock upon realizing the amount of $CO_2$ emission that one car journey causes (Bothos et al., 2014; Jylhä et al., 2013), and the fact that going by bike often takes less time than driving a car in the city center (Bothos et al., 2014; Wunsch et al., 2015). Studies viewed also confirm that the information of $CO_2$ emission caused by each route is vital information to the customers (Froehlich et al., 2009; Sonchor et al., 2015; Jylhä et al., 2013). Studies of mobility applications where information has not been personalized, such as the UbiGo (Sonchor et al., 2015) and the MatkaHupi (Jylhä et al., 2013), participants have expressed desire for more personalization of services, for previous search history to be logged and the possibility of viewing trip history.

Suggestions can appear as messages encouraging walking or biking when the distance allows for it (Bothos et al., 2016), or structuring of the different modes of transport in order to allow for optimal comparison in regards to for example $CO_2$ emissions (Bothos et al., 2014). Participants in an study encouraging biking received an email each night containing information on performance and expected weather conditions the next day (Wunsch et al., 2015). This proved successful and participants stated that the emails were "fun to read", and that they served as an encouraging reminder to take the bike the following day. Suggestions did not reach desired success in the SUPERHUB pilot, where participants responded poorly to the Facebook messages they received encouraging them to adopt more eco-friendly travel behavior (Gabrielli

and Maimone, 2013). However, participants in the study did say that they would like personalized suggestions, but that these were received inside of the application.

**3.3.1.4 Social persuasive features** Social features in mobile applications work as persuasive technologies based on the principles of social facilitation, social comparison and normative influence (Fogg, 2003). Social facilitation refers to the power of knowing what others are doing and the knowledge that one's own action are known to others, social comparison is effective because of the motivational increase that occur once we can compare our behaviors to others performing on a similar level, and last the normative influence that persuasive technologies posses when applying peer pressure in order to encourage or discourage a target behavior (Fogg, 2003). One example is when information was sent to customers of the company OPOWER, informing them of the energy consumption of people in their area, which caused a decrease in energy consumption equivalent to what an 11 to 20% increase in price would have caused (Allcott, 2011; Allcott and Rogers, 2014). Another example is when the guests of an hotel were encouraged to reuse their towels in order to reduce the environmental pressure of washing them every day; they were more inclined to do so if they were informed that other guests had already complied, and even more inclined if they were informed that previous guests in their very room also reused their towels (Goldstein et al., 2008). Below is a list of commonly used persuasive technologies using connectivity and social leverage, identified by Oinas-Kukkonen and Harjumaa (2009) and Fogg (2003). Applications within a mobility context are also described.

- *Competition* Using the natural human drive to compete can persuade users to adopt or increase the use of a target behavior.

- *Cooperation* Leveraging users to adopt certain behaviors when cooperating have persuasive effects.

- *Comparison* Informing users of other users behaviors that are on the same level can motivate users to improve on their target behavior.

Social persuasion is used in most of the viewed studies. In many of them comparison, competition and cooperation are featured together. Wunsch et

al. (2015) performed a study on persuasive techniques used in order to increase biking where an email was sent to participants each night, showing their scoreboard compared to other participants. Collective goals were also set, where participants had to cooperate to succeed. Feedback from participants entailed a desire to be able to compare and share scores to acquaintances outside of the study. The study was successful; an increase of 13.5% in biking was documented among participants (Wunsch et al., 2015). Hjalmarsson-Jordanius and van Amelsfort (2017) posted a challenge between two major Swedish cities on what city travelled more sustainable, using both cooperation, competition and comparison. The SU-PERHUB application featured both collaboration and comparison, however due to low numbers of participants it was not frequently used, and comments from participants suggested that low numbers was the main reason (Gabrielli and Maimone, 2013).

**3.3.1.5 Green defaults** Default is the option that is selected if the user or consumer does not make an active choice (Johnson and Goldstein, 2003), as a "path of least resistance" (Thaler and Sunstein, 2008). Despite not being many studies performed on the effectiveness of green default in the area of sustainable mobility, it is a persuasive strategy with great potential (Sunstein and Thaler, 2003; Bothos et al., 2015).

Default inertia is the tendency of consumers and users to stick to the default option, despite potentially less expensive or better alternatives (Bothos et al., 2015).The efficiency of default policies was highlighted in the study by Johnson and Goldstein (2003) where people's inclination to becoming organ donors was investigated, depending on if being a donor was the default or not. A third scenario was also investigated, where participants were forced to make an active choice, i.e. no default option. The results show that almost twice as many choose to donate when being the default, and almost as many in the forced-choice scenario. The study also examines countries where organ donation is the default and countries where it is not; for example in Denmark (where it is not the default) 4,25% agree to donate, and Austria (where it is the default) 99,98% choose to donate. It is arguably that such difference is not due to socio-cultural factors (Johnson and Goldstein, 2003). Another area where green defaults

have proven successful is retirement savings in the United States (Choi et al., 2006).

Defaults used with the objective of increasing sustainability, so called 'green defaults', have been proven efficient in the case of increasing the consumption of renewable energy by imposing a green energy default or opt-out policy (Pichert and Katsikopoulos, 2008; Ebeling and Lotz, 2015). Another example of green default is the carbon offset programs, where the opt-out to pay for the policy proposal generated far greater amounts than the opt-in (Araña and León, 2013). There are some evidence that green default policies are more effective on individuals with little awareness or regard to environmental issues, and that opt-out policies are overall favorable with green objectives (Theotokis and Manganari, 2015). Thaler and Sunstein (2008) argues that the forced choice is preferable when the decision is one of great importance.

In the context of promoting sustainable urban mobility, specifically mobile applications where sustainable travel is encouraged, implemented green defaults can demonstrate as environmentally friendly alternatives being visible at the top of every search for route options (Bothos et al., 2014). This will force car drivers to scroll through suggestions of biking, walking or using public transport at every search.

### 3.3.2 Gamification

Gamification of a mobile application or another ICT platform is one way of applying persuasive strategies. This approach is used as a value adding feature to activities that have nothing to do with games or gaming and is currently applied within different areas, such as corporational, educational, mobility, transportation and medical contexts (Sakamoto et al., 2017; Huotari and Hamari, 2012; Feng et al., 2018; Gossling and Stefan, 2018).

The term gamification has emerged from various attempts to incorporate game-like or play-like elements into activities in order to create engagement and feelings of joy and curiosity. It has been defined by Deterding et al. (2011) as "the use of game design elements in non-game contexts". This way of considering gamification has become very common, but the definition has also been elaborated with. Hamari, Koivisto, and Sarsa (2014),

cited in Gössling (2018), describe gamification as "the use of game elements in non-game contexts to enhance user engagement and learning effects". Some of the more frequently used definitions also consider the engagement of people to achieve behavioral change, as well as the use of addictive elements found in games to enhance motivation (Clarke et al., 2017).

Huotari and Hamari (2012; 2017), criticise the definition proposed by Deterding et al. (2011) and points out that games consist of both systemic conditions and experiential conditions, and that the way gamification is defined by Deterding et al., (2011) fails to involve the user experience as an important factor. The systemic condition is about how the game is designed and include conditions (or game elements) like rules, conflicting goals and uncertain outcomes, whereas the experiential aspect takes also the human involvement into consideration, referring to conditions like pleasure, mastery, immersion and relatedness. Further, the same authors claim that there are no such thing as elements unique to games. Huotari and Hamari (2012; see also 2017) have instead defined gamification from a service marketing perspective: "a process of enhancing a service with affordances for gameful experiences in order to support users' overall value creation". In this study, the definition proposed by Deterding et al., (2011) above will be adopted: "the use of game design elements in non-game contexts".

An important aspect pointed out by Huotari and Hamari (2012), originally taken from the service market theory but here applied to the field of gamification, is that the customer is, or should be, considered a co-producer of the service/game/gamified application because the value of a service is created only when the service is consumed. Thus, games are produced both by the game providers and the users or players. Olszewski et al (2018) seem to have adopted the same approach, stating that gamification is efficient only when people choose to become users of a given platform or application by free will.

The use of gamification is proposed to increase the users' awareness of certain issues and motivate usage of the ICT solutions provided in a specific context, in exchange for "status and reputation in the game, and earn rewards (either virtual or material)" (Kazhamiakin et al., 2015). Such rewards are example of game elements, mentioned in some of the above definitions. Frequently used

game-like elements are "points, badges and leader-boards; more advanced ones include levels, paths, challenges, missions, feedback, and user powers" (Kazhamiakin et al., 2015). Other type of elements used, also in transport related projects, are motivational affordances, ratings and comparative maps (Gossling and Stefan, 2018).

The reason for using certain game elements is because they represent different social needs. Game elements are supposed to be designed in a way so that personal needs can be fulfilled; for instance the motivation for adopting a challenge or solving a task under time pressure originates from the need of cognitive stimulation whereas badges, points and scoring systems relates to the need of achievement (Blohm and Leimeister, 2013). Further, it is seen that elements used in gamification are of the very same kind or similar to persuasive strategies / elements used in nudging. Therefore, the authors of this study treat nudging and gamification as homogeneous. Following, different game elements found in the studied literature will be categorized in relation to the persuasion strategies:

- *Positive incentives and accountability*: goal setting, points, scoring systems and feedback.

- *Social persuasive features*: leader-boards, rankings, challenges and group tasks.

- *Structuring complex choices*: route suggestion and route planning.

Most of the persuasive strategies mentioned in the previous sections have been adopted as gaming elements in various pilot studies that aim at influencing travel habits using gamification. The strategies included in positive incentives and accountability; goal setting, self monitoring and rewards, are all common elements in gamified applications.

Goal setting is regarded as a key feature according to Denny (2013) and is said to enhance intrinsic motivation (Sakamoto et al., 2017). The feature have shown to be both appreciated and considered non-interesting to users (Gabrielli et al., 2014) - one evidence of the variation in user preferences. Self monitoring is often used as feedback, as seen in Jylhä et al., (2013) and Gabrielli and Maimone (2014). Feedback is perceived necessary in supporting the goal as it informs the user whether the goal is achieved or not (Zapico et al., 2009).

Feedback is used to influence behavioral change and includes measuring of certain behaviors, comparison with norms and communication of what lies ahead (Weiser et al., 2016). Feedback can for instance be provided as emitted $CO_2$, which have shown to generate awareness of climate issues, motivation to strive for further emission reduction, but it has also resulted in feelings of guilt (Jylhä et al., 2013). Gabrielli et al., (2014) on the other hand argue that provision of feedback was not motivating enough to influence travel behaviors.

Rewards are considered effective in amplification of appropriate behaviors (Gabrielli and Maimone, 2013) but critics claim that rewards, as extrinsic motivations, should not be given to users if intrinsic motivations, such as genuine interest and curiosity for a subject or task itself, is desired (Weiser et al., 2016). Further, Weiser et al., (2016) states that there are no tested effects of including rewards in persuasive systems. As seen in the studied literature, rewards can be given for accomplishing challenges (Gabrielli et al., 2014) or for choosing off-peak travel times (Hu et al., 2015). It may be given as virtual badges (Kazhamiakin et al., 2015; Barratt, 2017) or as real discounts on products and services (Hu et al., 2015) for example PT tickets (Gabrielli and Maimone, 2013).

Structuring complex choices, identified as a persuasive strategy, seems to be widely used when it comes to gamified applications that aim at promoting sustainable travelling. Reduction of alternatives is a recurrent element in the form of journey planning as it suggests sustainable travel modes over taking the car (Gabrielli et al., 2014; Kazhamiakin et al., 2015; Jylhä et al., 2013) or certain paths based on shortest travel time, historical data or underutilization of paths (Hu et al., 2015). In the literature it is seen that suggestions given in gamified applications concern what type of travel mode to use in order to make travels more sustainable.

Personalization and tailoring have been used to make feedback, suggestions and challenges more appealing to users and seem to have been appreciated features when included (Gabrielli et al., 2014), and requested by participants when not included (Jylhä et al., 2013). Gabrielli and Maimone, (2013) states that personalization of triggers will enhance individuals' motivation, just like personalization of goals (Weiser et al., 2016).

One pilot study, initially large-scale, based suggestions on user data which was collected from participants' travel diaries. The fact that the participants were expected to document their travel habits caused many to quit the project. The high drop-out rate may also have been caused by the lack of physical meetings between study leaders and recruited participants (Gabrielli et al., 2014). According to Gabrielli et al., (2014) that could perhaps have been avoided with more "effective communication strategies". Simulation of users' emitted carbon dioxide has been used as feedback in order to motivate for sustainable travelling (Jylhä et al., 2013). However, people that won't change their behavior to lessen the environmental impact, may be more motivated by "collective, real-time data about pollution at city level" (Gabrielli and Maimone, 2013).

As for social persuasive features, competition, comparison and cooperation are features that are used to make the application and the activities more fun, motivating behavior change and reaching goals (Zapico et al., 2009). Individual competition, in terms of challenges promoting sustainable means of transport, seems to be quite common, but competition against others has come up as a request from project participants (Jylhä et al., 2013). However, for motivational reasons such as competition is suggested to work best within individuals' social networks rather than against strangers (Jylhä et al., 2013; Gabrielli et al., 2014). That goes for the comparison feature as well - participants in one project requested the feature and it was concluded that it could possibly have enhanced motivation for using the application. The MatkaHupi study showed that participants seemed to be willing to share and compare their results and successes, but only in their social network (Jylhä et al., 2013). Using leader boards with points can be used for comparing one's successes to others (Kazhamiakin et al., 2015) and can be very motivating and joyful for some (Barratt, 2017). The only strategy that is not mentioned specifically in the studied gamification literature is likeability and attractiveness.

Gamification is predicted to have a good potential to influence the transport sector towards sustainability and contribute to solving some of the related problems (Kazhamiakin et al., 2015; Gossling and Stefan, 2018; Olszewski et al., 2018). However, the importance of investments in urban infrastructure should not be disregarded or underestimated (Olszewski et al., 2018) as it has been seen that urban infrastructure is a hindering factor for extended usage of travel modes other than private cars (Organisation for Economic Co-operation and Development, 2014; Pajarito and Gould, 2017).

Pajarito and Gould (2017) has investigated "the use of mobile applications (apps) to incentivize the increased use of cycling for commuting". Some factors are identified seem to hold people back from cycling and concerns the perceived risks and discomfort related to biking. Such factors can be insufficient infrastructure, environmental conditions such as weather, air pollution, or the effort it takes going uphill (Pajarito and Gould, 2017). Further, Kazhamiakin et al., 2015 claims that the implementation of a gamified application has shown to be both "difficult and expensive". It partly has to do with the fact that each gamified application is design with regards to a specific context making it hard to assess the outcome and to reuse the design. As a response to this, there are several attempts to develop frameworks aimed at making the gamification process more efficient in terms of time, money and effort (Kazhamiakin et al., 2015).

### 3.3.3 Pricing

The persuasive strategies nudging and gamification, put forward in section 3.3.1 and 3.3.2 are predominately focused on persuasion through digital media, focusing on *users* of mobility services. As mentioned in the very beginning of section 3.3, affordability is a feature that, among other, make MaaS services attractive, meaning that the pricing of a mobility service can also be persuasive.

MaaS, as a disruptive innovation, may have the potential to improve sustainability of the road transport system. This will not only require behavior changes, but also new types of business models (Sarasini and Linder, 2017). A business model describes the financial structure of an enterprise (Zott and Amit, 2010) and enables value creation by finding and utilizing business opportunities (Teece, 2010). The business model is supported by pricing models that are necessary for the business to be viable on the market and generate revenue streams (Bae et al., 2014).

The literature is somewhat sparse when it comes to pricing of mobility services. Jittrapirom et al.

(2017) have looked into different mobility service schemes, stating that MaaS services uses two kinds of tariff options - subscription to the service package, and pay per use. According to the authors, pricing strategies suited for a multimodal service system should not cause a lock-in effect, which can be achieved by leaving out requirements of yearly subscriptions, avoiding add on costs that are not visible for the customer, and similar.

Just like Jittrapirom et al. (2017) suggested, the pricing strategies presented in table 2 below consist only of pay as you go and subscriptions. The table presents four mobility services; two MaaS-schemes, one bike pool and one carpool.

Table 2: Pricing among mobility service providers in different European countries.

| Service | Pricing strategy | Fees & Type of subscriptions | Other offers |
|---------|------------------|------------------------------|--------------|
| UbiGo. Pilot. Level 3 MaaS service. Gothenburg, Sweden. (Karlsson et al., 2016). | Subscription based. Pay as you go. | No registration fee. Monthly subscription; $\geq$ 1200 SEK/month adapted to the users' mobility needs, with a customized set of different mobility services included | Any unused credits could be utilized during the following month. |
| Whim. Operating. Level 3 MaaS service. Helsinki, Finland. *Source:* https://whimapp.com, retrieved May 2018. (Jittrapirom et al., 2017) | Subscription based. Pay as you go. | No registration fee. Monthly subscriptions for access to the bundle of services and pay per use for the four different mobility services. The monthly subscription are set to 0€, 49€ and 499€ respectively. The first level of subscription is based on the pay-per ride concept only. For the second and third (premium) level unlimited access to PT is included; taxi rides of 5 km for 10 euros vs. unlimited; car rental for 49 euros/day vs. unlimited. | Premium subscription; giving unlimited access to the included services (the premium level is described in the column to the left). |
| BeMobility. Pilot study. Carpool; electric vehicles, station based and free floating. Berlin, Germany. (Ruhrort et al., 2014) | Pay as you go. | The tariff system is formed as follows: "0.28€/min (minute price), additional prepaid tariffs and a maximum daily fee of 39€, 10 free minutes are granted once a day for plugging in a vehicle with less than 50%" (Ruhrort et al., 2014) (p.20) | Free parking of the electrical vehicles was offered - a valuable feature as parking in Berlin is rare, according to the study. Integrated PT and offered a mobility card, providing access to different mobility services, valid for three months. |

| Vélo'v. Operating. Bike pool; station based. Lyon, France. *Source*: https://velov.grandlyon.com, retrieved May 2018. | Subscription based. Pay as you go. | Annual subscription for access to the service. The first 30 minutes of biking is free followed by additional fees every 30 minutes. | Special offer for customers to car parking schemes: 60 minutes of biking without additional tariffs. Companies are offered a lower fee than the common scheme. |
|---|---|---|---|
| | | | |

Out of these mobility services, only two of them belong to level 3; Whim and UbiGo. As mentioned in section 3.2, the purpose of level 3 services is to attract users from the private car segment by fulfilling their travel needs. In order to reach level 4 in the topology, sustainability goals such as decreasing congestion, accidents and GHG emissions has to be complied with. If the service fails to attract car owners specifically, the overall effect may be an increasing number of travels by car since an enhanced access to bundled mobility services will potentially facilitate car use for those who usually go by PT or bike, for instance. What must therefore be considered is that integrated services (also level 3) may bring about a "trade-off between environmental sustainability and accessibility" which emphasizes the importance of attracting travellers from the private car segment (Sarasini et al., 2017b). Ensuring sustainability and delivering sustainable values is said to be difficult, but necessary for a MaaS business model to be sincerely sustainable (Sarasini et al., 2017b).

### 3.3.4 Attributes of mobility services

Concluding, section 3.3 covers persuasive approaches that foremost are directed towards people that are already users of a mobility service. Pricing of mobility services however will contribute to the attractiveness and motivational nature of the service itself. What actually seem to have an impact on attitudes towards sustainable travelling is foremost the flexibility, affordability and convenience that the service offers, shown in the UbiGo trial (Karlsson et al., 2016). According to Karlsson et al., (2016) people tend to be non-flexible in their choice of transport when deciding to either buy a private vehicle or a PT pass. How-

ever, users of the UbiGo service expressed that having access to a multitude of different options made it easier to adapt the mean of transportation to each trip (Karlsson et al., 2016) and made it possible to freely choose how to travel (Sochor et al., 2015) - the multimodality of a mobility service seems to be appealing since it can be adapted to various preferences of how and when to travel (Ruhrort et al., 2014; Karlsson et al., 2016; Sochor et al., 2015).

It is seen that having the opportunity to be flexible, making decisions for oneself regarding travel mode, route and time, is not just a practical feature but does also have "a symbolic value" according to participants in the BeMobility project (Ruhrort et al., 2014). Flexibility is closely connected to the perceived convenience of the mobility service, allowing for optimization of users' travels that satisfies their needs no matter what time of the day it is (Ruhrort et al., 2014). This implies that a MaaS service itself, providing these features, serve as a motivation for a changed attitude and behavior regarding sustainable mobility and sustainable travelling (Sarasini et al., 2017b). It is also worth mentioning that in the UbiGo pilot study for instance, people without previous access to a car gained access within the service (so called *car accessors*), ultimately influencing their travel behavior towards driving more (Sochor et al., 2015). However, there where also many users that put their car away during the study (so called *car shredders*), obviously causing a reduction in their car usage.

# 4 Mobility service providers in Sweden

The following chapter will present the results from the twelve interviews that were conducted in order to answer the research question of how strategies aimed at incentivizing sustainable travel behavior are applied among Swedish mobility service providers. It begins with a short introduction of what type of mobility services that were represented during the interview sessions, followed by a presentation of the findings stemming from the respondents interviewed.

## 4.1 Description of a selection of mobility services in Sweden

Twelve different mobility services are represented, including station based and free floating car pools, a pod taxi service, public transport, a train operator, a carpool service for tenants of a real estate manager, a provider of electrical vehicles and other mobility solutions, and two service concepts trialled in 2013/2014 and 2016/2017 respectively. It should be noted that all service providers conducted persuasion, either through persuasive traits of the service or through the pricing of the service.hence those strategies are not featured in table 3.

Table 3: States what persuasive strategies are employed by the mobility service operators included in the interview study, what their sustainability effects are and what their MaaS topology level is.

| Service | Topology level | Strategies employed | Stated sustainability focus |
|---|---|---|---|
| P1 | Level 0 | P1 only applies supportive strategies as they structure complex choices by eliminating steps when their customers book cars. | Ecological focus; Vehicle fleet is electrical and causes no emissions. |
| P2 | Level 0 | P2 uses suggestions as a mechanism, for example through messages like "take a detour", motivating their users should plan their trips, and stressing the advantages of not owning a car through messages like "now we've changes the tires, do something nice this afternoon!" | 30 customers per vehicle. One pool car replaces 5 private cars (Indebetou and Börefelt, 2014). Considers driving in itself unsustainable, in contrary to walking, cycling and public transport. |
| P3 | Level 0 | P3 focuses on the difficulties of owning a car, and want people to start by leaving the car one day, being the first step towards selling the car. The service creates incentives to think about travel habits and costs. | Aims to substitute car ownership for people who do not need a car. |
| P4 | Level 0 | P4 employs feedback in the shape of messages on receipts, thanking users for "not letting the environment pay the price". Uses likeability and attractiveness on their app and web page (supportive strategy). | Tackles both social and ecological sustainability; aim to be a fair employer and possess vehicles that causes no emissions. States that pod taxis substitute taxi cars, which are usually "big and emission intensive". |

| P5 | Level 2 | Employs campaigns directed specifically towards car owners, which receive two weeks of public transport for free. Targets workplaces and companies to collaborate on getting employees to travel sustainable. Help customers structure complex choices in their route planner | Social focus: Accessibility with public transport, and access to public transport for everyone - to ensure that everyone feel safe when using the service. Resource efficiency: to travel together makes much more sense than to travel alone (also has social implications). |
|---|---|---|---|
| P6 | Level 2 | Mainly campaigns, both to promote biking to work but also targeting work places, posing challenges among employees to encourage sustainable commuting in an social environment. Supportive strategies such as structuring of complex choices. | Provides ecological advantages by being more resource efficient than e.g. cars (one bus can 'fit' 50 buses). Equality: everyone has a right to public transport, not just those living in urban areas. |
| P7 | - | Social persuasive features: P7 develops an app promoting sustainable business travels, where work places will be able to compete between each other and employees will be able to compare to company average. | Makes public transport more available and accessible by facilitating collaborations between actors through standards, data sourcing and combined mobility. This contributes to increased use of public transport. |
| P8 | Level 2 | Campaigns and trials: promotes trying something new. Simulation: Shows customers the amount of CO2 saved by not driving a car. Rewards: allows users to gather points to spend on more trips or other travel related items. Structure complex choices: saving user preferences and provide route planners. | Provide environmental benefits by drastically reducing emissions compared to the same distance travelled by cars. |
| P9 | Level 0 | Supportive strategies: applied in a previous app. Structuring complex choices: route planner. | Focus on land use in cities; sees that if tenants live in central areas, the need for car ownership decreased compared to living in the suburbs. |
| P10 | - | Persuasion through the service itself: creating mobility solutions - superior on the market, meaning no other persuasion will be needed. | Reduced emissions: Sustainability through electrification. Resource efficiency: autonomous cars. Safety in traffic: and redesigning of the vehicle hardware. |
| P11 | Level 3 | Rewards, structuring complex choices, defaults as well as social persuasive factors were applied in a pilot study. Duration time: five months. | Mainly ecological sustainability; P11 argues that social factors can not be prioritized before establishing a user platform. |
| P12 | Level 2 | Rewards, challenges, social persuasive features and structuring of complex choices were applied in a pilot project. Campaigns were used to attract users. | Promotes sustainable travel modes such as cycling, walking and public transport. |

## 4.2 The prioritization of sustainability issues among mobility service providers in Sweden

The interviewees and their respective organizations have different views on sustainability, its implications and their part in contributing to or handling specific sustainability issues. Their views involve how they perceive sustainable road transportation, what issues they see as most critical and what sustainable values they add to individual transport as a result of their respective mobility services. This chapter will help tie the service design, and how these organizations aim at stimulate their customers and users to to change their travel behaviors, to their sustainability aspirations.

*Attitudes and responsibility*: The majority of the services providers interviewed considered environmental sustainability as a driving factor for developing and provision of their services. They all saw their service as an option for people to not use a car or at least lessen the dependence of a private car, and argued that it would lead to better environmental conditions. Also, the trust in technology as a solution to sustainability issues in the road transport sector seemed to be high among the respondents. Many of the organizations represented use or aim to use electrical vehicles. In contrast, one respondent (P2) argues, "There is a need for radical measures where one simply stops doing things, not just doing them differently", referring to the insignificance of the difference in emission level for different car models compared with simply not using a car.

Several respondents considered the individual choice of transport as the most important aspect of sustainability in the transport sector. Deeming the act of driving a car as unsustainable, these respondents agreed to cycling, walking and using public transport as the only means of transportation being truly sustainable. On the other hand there were respondents stating that people will choose the mode of transport that make their everyday travelling as easy as possible. They meant that the commercial sector together with the authorities and politicians has responsibility to provide better alternatives and better conditions to enable people to choose more sustainable means of transportation.

*Land use*: All of the respondents recognize land use as a sustainability issue closely linked to car use. Some of them argued that fewer cars on the roads and fewer parking lots would open up for the possibility to build parks and open-air cafes which would entail more attractive urban environments and promote social interactions - P5 stated that "If there are people on the streets instead of road barriers there is a chance of running into a friend".

*Resource use*: The fact that many vehicles are not used to their full potential is something that appeared to be an issue to many of the respondents. Most of them considered their service to be more resource efficient than private cars, referring to utilization rate and type of energy source used. In order to cope with these issues, one respondent aimed to encourage corporate customers to let employees drive a company car home in the evening and bring it back in the morning, making it possible for them to not use a private car. Further, another respondent implied that utilization and circulation of their vehicles were enhanced by allowing customers driving a pool car from the suburbs back to the city center at a reduced price. One organization has an ambition of creating a car fleet that will never be abundant due to autonomous technology enabling cars to perform other 'tasks'.

The view on public transport as environmentally friendly was parted between the interviewees, one pointing at the fact that a bus can "fit 50 cars" (P6 referring to the number of people fitting into one bus). This was opposed by a respondent stating that many city buses run with few passengers, while being diesel fueled. Some further argues that better planned trips and a higher degree of co-riding can increase resource efficiency.

*Emissions*: About 50 percent of the respondents recognized carbon emissions as one of the most critical sustainability aspects connected to the road transport sector. Comparing different modes of transportation one respondent (P8) pointed on the great environmental advantage of trains, claiming that 50000 train rides releases the same amount of emissions as 25000 car rides or one single flight on the distance between Stockholm and Gothenburg. Similarly, one respondent stated that "bike, walking and public transport are the best alternative from an environmental perspec-

tive" (P5, confirmed by P2 and P11).

Vehicle fuel was another topic related to emissions, brought up during each interview held with the carpool representatives. All three of them voiced that electrical vehicles would be the best choice from an environmental perspective. However, two of the respondents claimed that the current charging infrastructure is insufficient, stating this as a reason for not investing in more electrical vehicles. They were contradicted by the third, who explained that existing infrastructure is more than enough, driving electric cars simply requires a bit of planning. Also the pod taxi service provider criticized the charging opportunities, arguing that the existing stations are constructed to suit to cars and therefore exclude other types of electric vehicles like theirs, aimed at substituting conventional taxis.

*Social Sustainability*: Several respondents implied that their service, ranging from autonomous cars and electrical vehicle fleets, to public transport and integrated mobility services, have a good potential of bringing about social values and an increased life quality for individuals. It seemed, however, as the aspect of social sustainability would be less prioritized, or at least not the driving factor, than the ecological aspect for development and expanding of new mobility services. One respondent (P10) claimed that "self driving cars will solve many social problems in today's society" referring to the increased mobility that can be offered old and disabled people thanks to such technology. According to one of the public transport providers (P6), the public health will increase when going by public transport since "you are more active when using public transport". Some parts of the discussion about social sustainability concerned gaining experiences while travelling and the social value created in personal meetings, in order to justify the need for continued travelling. For instance, one respondent (P2) claimed that "even though you don't have a car, you can do things that are important to you", referring to the benefit of being member of a carpool. Another interviewee (P10) voiced that "travelling per se has many social benefits that cannot be replaced".

*Access to transport and Accessibility*: Many respondents seemed to agree that mobility services, at any topology level, offer accessibility by allowing access to a car when needed. Except from this reasoning, there was a general conception among mobility service providers that their services are highly accessible. However, the respondents did not distinguish between accessibility and access to transport, instead making general statements about ease of access to their own individual services. One of the public transport providers (P6) reasoned that even though they make sure their vehicles are accessible in terms of space for wheelchairs and strollers, they can not answer for how people with disabilities for instance, should get to the bus stop; "... this is more of a societal question, and we simply cannot do anything there". Another representative of public transport added that in order to compete with cars, the bus cannot stop as often as desired, considering this as a compromise between access and time efficiency. It was also stated that access to the public transport is crucial, as everyone are entitled to public transport, not just those living along popular bus routes. Space for wheelchairs, strollers, and seats for seniors, was identified to be a compromise between access to transport, space for 'everyone' and safety.

*Equality*: There were different approaches to the topic of equality in traffic among the respondents, concerning both equality between sexes and socio-economic equality. Some of the respondents agreed upon that there is a difference between genders regarding the perceived feeling of security. This applied to public transport and shared mobility. In the case of public transport, one respondent gave an example of a transgender passenger, and how that person might not be safe in a public context as a tram or a bus, voicing that it partly depends on a culture seen among other passengers. Coping with this issue, the respondent stated that "We contribute to West Pride every year, and try gain more knowledge about such issues", also pointing towards the seven grounds of discrimination that exist in Sweden as something that needs to be considered. In the case of shared mobility and equality, one respondent expressed that people who are not cis-men to a large degree experience insecurity and fear in traffic. Regarding this as an argument against shared mobility, a female respondent expressed: "For my part, I would never go home on a Saturday night with a male driver in a closed car."

Equality in terms of economy was approached by one service provider (P11), reasoning that developing and expanding their service might contribute to gentrification, as they needed to focus

on areas where people have a high 'mobility budget'; "... we want to start with people that have a car and that are capable of paying for quality."

*Safety*: The issue of safety in traffic was acknowledged by only a few respondents, relating to it as safety on board and, in contrast to the literature, reliability of transport and infrastructure. One of the public transport providers (P6) stated that "it is safer to go by bus than by car" while the another respondent (P5) elaborated with the thought of allowing people to bring their bikes on all buses and all trains (it is allowed on some routes), in order to increase the possibilities for sustainable travelling, but concluded that such initiative would be dismissed as "it would compromise travellers' safety". As for safety in terms of reliability of transport, one interviewee argued that in similarity to the car traffic being dependent on undamaged roads, the railway traffic requires rails that are at no risk of breaking and functioning communication systems. If preventive measures are not taken, it may lead to accidents and delays - implying that it is of importance that customer can feel secure about the punctuality of the train.

*Economic Sustainability*: Out of the three dimensions of sustainability, the economic aspect was the least discussed during the interview sessions. It was framed only in terms of cost-efficiency, but not job creation, innovation etc. Some of the respondents argued that some services would be cheaper to use than owning a car and thus benefit one's private economy - given that the mobility service fulfills the user's mobility needs. For instance, one respondent (P11) claimed that "public transport is cheaper than car use", while another respondent (P8) comparing the cost of taking the train with taking the car, arguing that "if driving alone, the train will be cheaper". Elaborating with the economic aspect of public transport, one respondent stated that no public transport is ever cost efficient since the government pays about 60% of every ticket purchased, implying that the more people using public transport, the bigger the cost for taxpayers become.

## 4.3 Persuasive strategies applied by Swedish mobility service providers

This chapter summarizes what strategies were found to be used by the mobility service pro-

vides interviewed. Some mechanisms that were identified as persuasive in the literature was used without any intention to persuade users, but will still be described as they can have persuasive effects. Overall, the belief in persuasion through nudges and gamification was low; the service providers were more prone to trust that their service and pricing were enough to stimulate behavioral change. Many argued that these kind of mechanisms can be, at best, "icing on the cake" and still depend on the existing mobility service in its ability to have an effect on users' mobility behaviors.

### 4.3.1 Positive incentives and accountability

*Feedback and self monitoring* are to a large degree not used by mobility service providers in Sweden. There seem to be different ideas on whether or not users of mobility services need to be informed or reminded of environmental benefits and receive positive feedback thanking them for choosing 'green' transport modes. However, some consensus seem to exist on the advantages of thanking customers for traveling environmentally friendly. Three respondents either sent emails saying thank you to their customers for not "letting the environment pay the price" or showing them the saved $CO_2$ emissions and thanking them in a mobile application. Self monitoring, allowing users to keep track of travels and progress in terms of set goals, is used by one service which have their users log in to store personal information, customer number and so on. The purpose is not to persuade but to allow users to store data and sparing them the trouble of stating their information every time they buy a ticket. Another respondent mentioned plans to launch an application which would be targeting business trips, persuading users through self monitoring and other features such as competitions and comparison. A MaaS level 3 provider stated that sending emails and newsletter to their customers not just provided them with feedback and information, but also promoted a sense of belonging among their users and made them feel cared for. P11 said: "Everything that fortifies loyalty and belonging to the service is positive and makes customers feel like they are part of something bigger, which persuades them to use the service more".

*Rewards* seemed to be one of the most recognized

persuasive mechanisms among the respondents. In the case of public transport, trains and the MaaS service, it is mainly used to encourage customers to use the service more; for example by rewarding customers for each ticket; or by giving a percentage of the price back when buying a certain number of tickets in one week. According to all respondents this means encouraging sustainable travel behavior, because they consider sustainable travelling to be a result of their own service. Rewards should be integrated in the service along with any incentive created, a number of the respondents stated. Two claimed that they found that rewards on unrelated goods or activities are not efficient nor wanted among their users. Some respondents also stated they used physical rewards, such as buying coffee and cake for a workplace that had completed a challenge. This, according to some respondents, has a social advantage, where participants will get a positive experience and share it with their colleagues. The respondent (P6) said: "It becomes a social event and something positive to talk about".

### 4.3.2 Likeability and attractiveness

The main design idea of most mobility services, both mobile applications and web page, seem to be simplicity. One respondent stated that they want both their app and web page to be easily understood for elderly as well as teenagers. For example they include features such as accepting swish-payments in order to simplify the payment process. Another respondent stressed the importance of simplicity; they assume that their customers are in a hurry and need the information to be easily accessible. They see that there is a need for time efficiency, clearness and functionality within their app and website. They further state that, since being a public transport provider, they have no need to present themselves to new users or market themselves in any way. P5, a public transport provider, said that: "We simply assume that everyone living in this region knows who we are".

The literature on persuasion is very focused on digital media and applications, however for many mobility service providers the physical customer meetings are equally important in creating likeability and attractiveness for their service. For example, the providers of public transport see the physical meetings with their customers as the most important customer interaction, as their users do not open the app on an everyday basis. This is because the way to work or school is usually well-known; they do not need route planners or lists of departures because they know where and when their bus will leave, and what stop to get off at. One respondent stated that physical messages was more important than the ones received through an app, and that the screens they had put up in buses are one of their highest valued means of customer interaction. Another respondent also argue that their personnel are 'bearers of their brand', and they spend numerous hours and resources into making them feel a sense of pride in their mission and internalize the organizational values. They want the customers experience in their vehicles to be positive, and that the interactions with their drivers contribute to this, and believe that meeting is an important way of leaving an impression on users. The respondent (P4) said: "to say that price models is the only thing that matter is not only flat out wrong, but it is an extremely soulless way of looking at the future, society and human beings", referring to softer values being important to their customers.

### 4.3.3 Structuring of complex choices

The most used mechanisms found among the mobility service providers interviewed fall under the category of structuring complex choices. Almost all the respondents stated that they use either reduction, tunneling, tailoring, personalization, suggestion or simulation in either their mobile application or website. However, they are not seen by the organizations as means of persuading their users. These mechanisms have been defined in this report as persuasive mechanisms that facilitates the structuring of complex user choices. The purpose stated by the respondents of using the mechanisms mentioned above is in order to simplify the user experience, but also to avoid user error by saving previously stated information.

The route planners used by several of the respondents include reduction, tunneling and tailoring, and a few include personalization as they will store user preferences and sort results according to previous searches. The public service providers along with the train operator all mention that they wish to help their users not just during their trip, but also before and after, and their route planners expand beyond the stops of the train, bus or tram.

One example of reduction used in another context than a route planner is one of the carpool services that has removed the choice of car from their web page. The customer only states the number of km they intend to drive, and the site provides them with a car with enough battery charge.

Simulation of CO2 is used by a few the respondents, but not in connection to their route planner. Some respondents have little notes on the receipt, thanking their users that they choose their service and spared the environment. Only one respondent used suggestions in terms of messages encouraging users to travel more sustainable. One respondent used CO2-points, and another showed users in the mobile application how much CO2 they had saved compared to traveling the same distance with a car. P8 said: "We try to enlighten them [our customers] by making the information easily accessible, not just writing grams of CO2 but actually relate it to flights and car trips".

### 4.3.4 Social persuasive features

*Challenges and competition*: The interviews have shown that only a few service providers actually use challenges as a way of promoting sustainable travels within mobility services. However, as it is found to be a promising way of stimulating certain behaviors in the literature, what has actually been done is of interest for the study. The challenges that are used are mostly aimed at increasing cycling or public transport in favor of driving, and targeted at workplaces. As these challenges tend to target the everyday commuter, the focus on a place of employment aims both at providing a social context for participants and to facilitate marketing by targeting one company instead of individuals. Both public service providers interviewed mention that, because they target a wide audience, organizations often have a more homogeneous culture and are easier to reach than the general public. An example of a challenge is where employees at an organization are provided with a jar of beads, that are one by one removed from the jar each time an employee commutes by other means than a car. When the entire jar is empty, there is coffee and cake for the entire office. P6 said: "The concept was very visual and made everyone want to contribute".

Besides the fact that it is used to a fairly low extent, there are doubts about the effectiveness and accountability of such challenges. The CEO of a carpool service posed concerns about accidentally promoting the 'wrong' behavior, by for example encouraging and rewarding users who drive electric vehicles, thus encouraging unnecessary car trips. A MaaS service provider expressed that biking challenges might have a strengthening effect on bicyclists, but does not, however, stimulate more people to take up biking.

*Campaigns*: Several of the service providers interviewed used different types of campaigns in order to promote certain travel behaviors, and it is identified as one of the main persuasive strategies deployed by the respondents. The campaigns were mainly physical and promoted through mail, email, face to face meetings with corporate clientele and social media. The campaigns targeted specific groups and was performed by two public transport providers, a train operator and an actor launching a project promoting sustainable personal transport modes, of which all normally target a very wide audience.

Both public transport providers use trials where they focus on habitual motorists and give them a period (2 weeks or a month) of free public transport, aiming to exhibit how using public transport can be as flexible as taking the car. Both the train operator and the public transport providers have campaigns specifically targeting workplaces, where they want employees to use other means of transport than a car when commuting to work. Once a challenge is completed, the public transport providers provides the office with a reward meant to be a social event, for example cake and coffee, and after the initial campaign they leave it up to the office of pursuing similar campaigns. P6 said: "We want to work with method development, and to provide work places with tools to create more incentives". One of them states that have had "bike-to-work" campaigns for over 20 years, which indicates they have been successful.

### 4.3.5 Defaults

Default is, similar to structuring of user choices, a strategy of persuasion that is used among respondents but not viewed as persuasive. Defaults are for instance used in route planners, providing an opportunity for the users to sort the results with respect to for example time or number of mode changes. Green defaults on the other hand, giving the most environmentally friendly option first,

seemed to not be used. Services without any type of search option or route planner can also use defaults, which is seen for one of the carpools include a insurance that is chosen unless the customer actively opts out.

Multi-modal mobility services such as level 3 MaaS services, have more opportunities of using defaults where they can choose to show 'green' transport modes at the top of user searches, despite environmental consciousness not being the main reason. P11, the only MaaS level 3 service provider in the study, uses defaults that show public transport at the top. The respondent gave a number of reasons for this, of which sustainability is not at the top. They argue that, as they are dependent on some stakeholders more than others, they have obligations to show certain modes at the top. The most important partner to have on board in level 3 MaaS projects in Sweden is the public transport provider. P11 said: "If we are to be able to operate at all we need the public transport, and they would be mad if we listed private cars before public transport because it was faster".

### 4.3.6 Pricing

Pricing of mobility services can effectively steer users of the services in different directions. Making costs visible and avoidable is found to make people aware of their transport habits. Several of the respondents mean that high prices of rental cars creates incentives for users to plan their trips carefully. The user can accomplish more than one task, and even consider sharing the car with a friend to keep costs down. On respondent (P11) explains that their service is designed to be too expensive to use a car every day, stating: "If you need your car every day, you will keep it and not become a customer. It would be too expensive." Another respondent argues that charging rides per unit is to be applied to all travels, which will be possible once the cost of drivers disappear with self driving cars. This will, according to the respondent, make people aware of the cost of traveling (opposite to driving a private car) and reflect on their transport habits.

The public transport providers both talked about lack of flexibility due to their ticketing system. It seemed as there is a demand for inclusion of tickets that making it easier for people to use and commute by PT without having to sign up for a months travelling. Regarding different life situations, one respondent gives an example of a single parent that needs a car every other week when he/she has the kids, but who uses public transport the rest of the time. In such case the monthly subscriptions would be too expensive and, interpreting the respondents, the single ride tickets seemed to not be suitable or attractive enough. One of the public transport providers were currently developing an offer to reach this group, while the other public transport provider recognized the issue, but did not have such offering at the time being. They did however offer their monthly subscribers to bring three people under the age of 20 on the bus or tram, with the purpose to for example allow for parents to take their kids places on the weekend without paying extra. This could facilitate for car owners to not commit to full time public transport right away, making the threshold of leaving the car at home smaller. It also shows that providers of PT aims at adapting to the fact that one can be both a car owner and a PT user. P5 said: "I would rather like to be able to tell people that they could leave the car at home two days a week".

The simplicity and straightforwardness of pricing are pointed out as two main attributes, important for customers to be motivated to use a mobility service. Many respondents claimed that their way of pricing their service was the most simple, stating that their customers "pay for what they get" and that the final price is clear beforehand. What a 'simple' price model is exactly, seems to be a question of debate as some respondents called other respondents' way of pricing complicated. What some respondents agreed on is that variable costs are hard to predict for customers, causing frustration and confusion. An example, told by one respondent, is when customers of a residential carpool attempted to rent a car but found it difficult anticipating the final price, ending up taking the car instead. What is agreed upon by most respondent however, is the fact that the pricing of the service is important for persuasion. P4, who charges customers per meter, said: "Our basic thought is that our customers pay for what they get, and this seems to be appreciated".

### 4.3.7 Persuasive service traits

Persuasion by the service itself refers to the mobility service, and its design, as a motivational fac-

tor for people to change attitudes about the way they usually travel. Depending on its design, the mobility service may contribute to reducing the need of being owner of a car and thus serve as a persuasive strategy - an incentive for sustainable travelling. The organizational representatives interviewed, working with mobility and passenger transport, aim at develop services serving as flexible and convenient alternatives to using and/or owning a private car. The reason being the identified need among customers for being mobile without owning or using a car, as well as the environmental benefits it will provide; P9: "The younger generations are less interested in owning a car, but still need to be mobile".

Hence, there are different motivations for the development of mobility services. From the interviews it was seen that all of the respondents consider behavioral change as key for reaching a more sustainable state in the road transport sector - for instance, one respondent (P10) argued that "if we can't get the over all travel behavior to change then the small things will not be significant to change". However, there were somewhat varying opinions about what incentives that would be required to to stimulate a behavioral change. Some meant that public authorities can and should affect travel behaviors as they have the mandate to influence city planning, which can be designed and restructured in a way that favors mobility services other than cars; P7: "... I suppose there are different ways, from the public sector, to create incentives and stimulate the use of 'the right' services - changing parking norms, accessibility to parking lots, prices for parking, city planning". Further, what was commonly seen among the respondents was the view that organizations, like the ones represented in this study, can create incentives for people to change the way they travel by providing attractive alternatives to car ownership and adapting the services to the need of the users. Proving that the service could be an incentive for more sustainable travelling, one respondent (P11) told that "We removed a mental barrier for people. [...] We can create the change by making them [the users] dare to take the step" referring to motivating customers to become users of the service as a trial.

*Attractive alternatives*: According to the respondents, there must be a range of mobility services to choose from if car ownership and car usage is to be less attractive, and the attractiveness seemed

to be dependent on whether the service succeed in making the everyday travelling easier. The reason to why people are still using their cars, according to one interviewee is the many benefits/gains that it gives people, for instance privacy; (P10): "it is naive to believe that people will sacrifice these advantages for the good sake [sustainability]. There must be something offering the same benefits as car ownership". One respondent (P11) argued that "the quality of the service is 95% of everything" referring to what makes people willing to choose another way of travelling.

All respondents seemed to consider their own services as attractive alternatives, or to have the potential to become attractive alternatives, to car ownership. It was seen that the providers aimed at making it easy for the customers to choose their service by being close by, as expressed by one of the service providers (P5): "We are trying to offer alternatives and information for the whole trip, from door to door, for the customer", and similarly by one of the carpool providers (P3): "Our cars will be there when you need one". Some of the carpool providers market their service by pointing out the convenience of not having to deal with the hassle that comes with car ownership; P2:"it is easier than owning a car". The respondent of the real estate managing firm (P9) reasoned that they can contribute to lessen the car dependence by "building at sites where the need of owning a car is small" while at the same time working on including a mobility service in adjacent to their buildings. According to the respondent it should be as natural as having access to the internet, being included in the rent.

*Adapting to the needs of the users*: A recurrent theme during the interviews when talking about sustainable travelling and mobility services, was the importance of adapting the service to the needs of users. The reason seemed to be to motivate modal shift among people, car owners especially. The opinions of what factors, included in the service, having the greatest persuasive impact on users' choice varied; ranging between cost and time efficiency to convenience and flexibility. The general conception among the respondents is that very few users would change their habits for sustainability reasons alone. According to one of the interviewees (P10), the reason to this is that "people will always choose what is best for them. It is all about efficiency, time saving and price. It is really not about sustainability for the individ-

ual, [...] since you have to make your life situation work". One respondent (P11), strongly arguing against the use of persuasive strategies in apps and such, instead claiming that the service itself may be an incentive, said that "cost and time are the most crucial factors to our customers". Examples of services being more time efficient than private conventional cars were for instance train rides allowing people to do other things while travelling instead of concentrating on the road. Further, one respondent implied that with autonomous vehicles no one will have to bother to find parking lots in the city.

On the topic of convenience and flexibility, the respondents referred to convenience as not having to worry about practicalities that comes with car ownership, as having access to a car or other kinds of vehicles whenever you need one. It is all about meeting customers' or users' needs regarding their everyday travels. One of the carpool providers (P3) stated that "the modern human has a certain need for convenience" referring to the carpool as a service with great potential of fulfilling such need.

Flexibility, on the other hand, seemed to be strongly connected to a service that does not contribute to a lock-in effect, for instance a service that does not require the user to be tied to a subscription or mode of transportation exclusively. This was exemplified by one of the carpool providers (P3): "We focus on the convenience and the flexibility. You are never bound to us, but we will be there when you need us". One respondent (P8) regarded train rides as flexible since they can provide the possibility of taking the train one way, and another mode of transport on the way back, arguing that "[...] it is a freedom for the traveller" to be able to choose how to travel. However, paying for a subscription may have the opposite effect. Flexibility was also referred to as the frequency with which buses, trams and trains are going. According to one of the public transport providers the public transport includes both flexibility and convenience, perhaps not always time efficiency though, as biking sometimes is a faster way of travelling in the city. The respondent (P5) also added that "it [the flexibility of the PT] depends on the selection in your neighbourhood. [...] When you don't have to look at the bus schedule, then it is flexible".

Many respondents mentioned flexibility as an important factor to the transport system, the reason being to make mobility services suite the life puzzle of individuals. Thus, more than half of the respondents reasoned that the first step towards not owning a car, is probably not to make people sell their cars but rather to motivate users to leave the car at home and instead use a mobility service for a couple of days or a longer period of time; P5:"I would rather say to people to leave the car at home, two days a week"; P3: "Leave your car [at home], don't sell your car".

Persuasion for sustainable travelling using service traits, seemed to be an alternative only if it makes people's everyday travelling easier, or as easy as having a private car. Yet, none of the respondents seemed to vision a future completely free of cars, despite the fact that almost half of the services represented did not include cars. One respondent (P7) claimed that "In order to make it attractive enough to buy mobility services, there must be a good enough selection of services, and there must be cars available when in need of one". Another respondent (P11) stated that "The concept [of MaaS] is based on an everyday utilization of public transport and utilization of car in certain situations", where 'MaaS' is regarded as mobility services above level 3 in the MaaS topology. However, suggesting that MaaS services have the potential of substituting car ownership and thus generate sustainability benefits, the respondent further argued the effect might as well be an increased number of cars, and that it is all about the business model; P11: "The business model is crucial for it [the MaaS service] to be sustainable. [...] some business models might contribute to more car ownership", referring to the possibility that people that initially did not owned a car suddenly get access to one, and thus start to use it.

As mentioned above, if the service will serve as an incentive to more sustainable travel habits, the service design is important. One respondent (p6), talking about this, stated that one problem is that the most basic is that the system of the mobility services is often not available "for instance, there are no bikes or cars to borrow. The systems [for the mobility services] must be in place", also referring to the IT systems of the involved actors that has to be integrated.

The majority of the respondents were hesitant to the effect of nudges, and rather saw the service design and the deliveries or values of the service as the key to persuade people towards more sustain-

able travel habits, as exemplified by one respondent (P11): "It has to be easy to do 'the right' thing. The purpose of everyday travelling is to manage one's life situation, not to have fun and catch Pokémon".

### 4.3.8 Barriers to using persuasive strategies among mobility service providers in Sweden

As many of the interviewees expressed desires to either act more sustainable regarding a certain area, or to include more persuasive features in their service design, many also referred to why this was not possible, or difficult, for them to achieve. These potential barriers are interesting for this study because they provide insights to what barriers possible persuasion methods will encounter, and if any are more worth pursuing than others.

The most frequent barrier towards the deployment of persuasive strategies is the attitude and lack of knowledge among mobility service providers. Few respondents included any intentional nudging or gamification in their service. The MaaS level 3 service provider, who had rewarded points to users that traveled sustainable said: "It is not the possibility of earning points that determining how you get to work on Monday morning", meaning that convenience and practicality triumphed challenges and points in the mundane commuting. Another reason that was stated for not employing persuasive technologies was the added administrative costs every time a new feature was added to the mobile application.

## 4.4 Future trends

Among mobility service providers in Sweden today, more and more are investigating the possibility of combined mobility; to include other services in their offer or allow for second party sales of their tickets. More than half of the respondents stated their involvement in collaborations with other service providers; a few were operational while others were in the development or ideation stage. One example is the public transport provider that is starting a collaboration with a parking firm in order to see what kind of service combinations that can be attractive.

Workplaces are a promising arena, both when conducting campaigns and challenges to stimulate sustainable mobility habits, and to establish new mobility services. Both public transport providers claim that they target workplaces because they are a more homogeneous group than the general public. Because of corporate culture the offers can be more specific than regular public transport campaigns, and participants in such campaigns or challenges acquire a social context from the start. One respondent said that "I believe that in the future it [public transport] will be more niche-focused, to make efforts to reach certain target groups in order to be more specific". One respondent stated that targeting employers is a way of marketing, that using a service at work allows people to try it, which can lead to them being customers privately as well if they are pleased. Another respondent is developing an app that will provide incentives to choose more sustainable transport modes on business travels. The app will allow users to buy public transport tickets, to log their trips and compare to both their colleagues and the company average. It will also pose challenges between workplaces on who travel most sustainable.

In order to target specific mobility groups with similar transport habits, storing GPS tracking data provides many opportunities for mobility services to gain knowledge about their customers. Respondents are positive towards using these measures in order to both apply different persuasive measures like rewards or suggestions, and to make offers and challenges more tailored. This entails many opportunities of persuasion, and to identify trends in users' mobility needs.

# 5 Discussion

Connecting results from the literature review with the practices and attitudes of the respondents, we discuss what, why and how persuasive strategies are deployed by mobility service providers in Sweden, what implications mobility service providers perceive their service to have on sustainability. Arguments stated in this section are supported by findings in the literature and put in relation to the research questions; *What type of strategies exist to incentivize sustainable travel behavior?* and *How are these applied among Swedish mobility service providers?*.

## 5.1 Impact categories

Most interviewed service providers considered their service to be sustainable in itself, therefore contributing positively to sustainability by simply attracting more customers. The impact categories in section 3.2 highlight and briefly explain negative effects caused by motorized road vehicles, and are mitigated through the decrease of conventionally fueled vehicles on roads. As all mobility services represented in this study claim to substitute private and/or conventionally fueled vehicles to varying degrees, it can be assumed that these mobility services contribute to the mitigation of land use change, global warming, negative effects on human health and acidification. It is possible that this attitude is the reason why two of the carpool providers seemed unwilling to invest in more electric vehicles in their fleet; viewing their service as sustainable, further investments towards sustainability may seem redundant. Most respondents showed a high awareness of environmental issues and how transport systems of today are not sustainable in many aspects. It was noticed however that the sustainability impacts recognized concerned mainly the local environment, and little consideration was taken to the effects of production and the afterlife of the vehicles, implying a lack of system perspective.

It is problematic to state that mobility services automatically will enhance ecological sustainability, since indirect effects are hard to anticipate. Jung and Koo (2018) conclude that car sharing services can in fact cause an increase in greenhouse gas emissions due to a potential modal shift from public transport to car sharing. This is an example of how services that are assumed to be environmentally friendly might be less so, due to an increased access to cars for non-car owners. One example of services contributing to indirect negative effects, is the case of carpools that sometimes use dynamic pricing in order to increase occupancy rate of their cars. This can mean that taking a car from the center to the outskirts is expensive, but driving the same distance in the opposite direction (back into the city) is much cheaper. This is stated as a way of being more resource efficient. However, this can instead cause people who otherwise would have used public transport to drive a car because of the low price. Someone set on driving will probably not bother looking for carpool vehicles in the vicinity, however someone going by public transport might be more likely to look for alternatives, if it can provide a higher degree of convenience. Some of the respondents referred to studies ( e.g. Indebetou and Börefelt (2014)) where results show that every car in one of the station based carpools substitute five private cars on the road. It should be mentioned that the study referred to is commissioned and sponsored by one of the station-based carpool providers, performed by a consultancy firm, and is not peer-reviewed by a neutral part. There is thus a possibility that these numbers are somewhat overestimated, and that they are not applicable to free-floating carpools. In any case, these numbers can change along with vehicles becoming autonomous, and mobility services increase in flexibility and convenience. Considering this, one can argue that a change in travel behavior towards bicycling and walking as opposed to driving is necessary to avoid growing numbers of vehicles in urban areas.

When asked what aspects that are most critical in order to achieve a sustainable road transport sector, there were many respondents mentioning issues concerning ecological sustainability rather than social. Two respondents expressed the belief that environmental issues was of greater urgency than social, an argument supported by Rockström et al. (2009). Another respondent argued that reducing number of vehicles, adding benefits to ecological factors, also leads to the promotion of social interactions. The reason to why this was mentioned was that the absence of cars will lead to less roads being built, opening up for more parks and other recreational areas. The social issues lifted during interviews include how norm-breaking groups (due to e.g. their sexual orientation, gender expression or ethnic belonging) might not feel safe when using public transport, and socio-economic factors such as class. The majority of these issues are of larger societal implications, and do not stem from transport alone. As this is the case, these issues are hard to battle and are dependent on complex societal structures that go beyond any transport systems and mobility trends. The low priority of these issues among the service providers might be an effect of this complexity. In the literature, social factors related to transport were for example inequality between motorists and cyclists (Gössling, 2017), how situations in traffic are experienced differently based on gender (Yavuz and Welch, 2010) and how low income population is over-represented in traffic deaths (World Health Organization, 2015). Raising issues that lack correlation to mobility and

transport gives respondents reason to say that these are out of their hands, just like one of the public transport providers argued regarding the ability of physically disabled to move to a bus stop. However this is true or not, to instead focus on issues that can actually be addressed and prevented through mobility services is arguably more useful.

There is a consensus around the fact that environmental benefits rarely are contributing factors when choosing transport mode or service every day, which is also supported by the literature (Sochor et al, 2014; Froelich et al, 2009). Some of the respondents even stated that they restrained from stressing the environmental benefits of their service in order to not appear pretentious. These findings from interviews and results from the literature review imply that mobility services conduct trade offs between social and ecological sustainability, and that users conduct trade offs between sustainability and practicality.

## 5.2 Persuasion through mobility services

*Communication with users through digital media platforms*: The literature concerning persuasion in mobility contexts focuses on digital nudging and gamification, possibly because this approach is more general and less site-specific than persuasion in physical environments, for example bicycle challenges or different kind of campaigns. In a majority of the reviewed studies (e.g. Jylhä et al, 2013; Gabrielli and Mainmone, 2013; Bothos et al, 2014; Froelich et al, 2009), communication and user persuasion was performed through mobile applications.

When proposing and encouraging certain travel behaviors for users of mobility services, how communication occurs is crucial for the appearance of the persuasion. However, when interviewing mobility service providers, the importance of their mobile applications regarding customer interactions was not stressed in the same way - findings show that functionality was the main focus of their digital media platforms. Concerning everyday travel, the fact is that users rarely look at travel planners since routes to work or school are usually well known to him/her. Thus, customers to some of the represented mobility services were assumed to not use the app or web-page on a daily basis, and when they did it was with the purpose

of finding information quickly. Further, many respondents stated that actual physical customer interactions are more meaningful than the digital, and served as their main path towards meaningful user relationships.

Evidence from the interviews point towards a lack of knowledge and competence regarding persuasive strategies among mobility service providers. Two of the respondents were familiar to these concepts and had applied them in previous projects. Despite of this, they were both skeptical towards the effects, saying that such strategies would have minor, if any, effect compared to persuasion through price models or the service itself. Sarasini et al. (2017b) calls nudging "underutilized in terms of the influence it can have on people's behavior and perception of different options available to them". The under-utilization of persuasive strategies is found to be true. Without possessing any deeper knowledge of the subjects of nudging and gamification, the majority of the mobility service providers agreed that these features will have little to no effects and are therefore not prioritized in the service design. In the literature, studies applying persuasive strategies aiming at stimulating sustainable travel behaviors were trialled during short time periods; average duration time is 4,9 weeks, excluding the UbiGo trial which is the only long terms study, running for 5 months. Due to this, effects of persuasive strategies applied in these studies are hard to discern from novelty effects. Further, as most studies included numerous strategies in the applications, credit effects to specific persuasive strategies is hard if not impossible.

One reason behind the mobility service providers' mistrust of the mechanisms described in section 3.3.1 and 3.3.2, is the notion prevalent among a majority of the respondents that mundane travels does not correlate to the collection of points or being persuaded through default settings in route planners. One respondent stated that on a Monday morning, users will not care about gathering points but rather what is more convenient and practical. As expressed by some respondents, an issue connected to this is rewarding certain ways of travelling that is not included in the mobility service. Take for instance walking or using a private bike. Despite them being the most sustainable ways of travelling, they will not generate any rewards. One respondent mentioned that they had considered rewarding sustainable travel be-

haviors in terms of using carpool vehicles, but that might create incentives for users to drive more than needed which made the respondent hesitant. The fact that all service providers thought of their service as being sustainable, might make them less likely to promote sustainable travel behavior since they already believe that simply using their service contributes to sustainability. Most persuasive strategies discussed during the interviews are aimed to increase usage of their service which, according to the respondents, is the same thing as stimulating sustainable travel behavior.

The most frequently deployed type o persuasion strategies among the respondents was supportive persuasion, which includes structuring complex choices and likeability and attractiveness, as opposed to deliberate persuasion which includes positive incentives and accountability, social persuasive features, defaults and gamification. Almost all respondents stressed the importance of simplicity; both in price models and in mobile applications and web pages. That meant application of mechanisms such as reduction, tailoring, tunneling, liking and expertise. The purpose of applying these mechanisms is most likely to enhance the persuasive abilities of the system, making customers and users more impressionable to any type of persuasive features, even if the respondents would not have used these words.

As mentioned in section 3.3.1 utilization of nudging is somewhat criticized by Barr and Prillwitz (2013) claiming that it undermines the importance of policy measures and relieves politicians from responsibility in transport questions. They identify nudging as a risk of putting the responsibility on individuals, consequently classing regulations and policy instrument as redundant. Arguably it is not this simple; the responsibility of a sustainable road transport sector does not lie solely on individuals and organizations nor on policy-makers. Also, considering the MaaS topology, the highest level implies that, in order to achieve truly integrated combined mobility, integrated mobility services need to comply with societal goals including policies, institutions and incentives of city planners. Confirming this, Henriksson et al. (2011) found that policy measures such as congestion charging can be effective as a 'tipping point' for people that already consider altering their transport behavior. Changes in societal trends can lead to development of commercial services, thus affect building norms, facilitating the existence of such

services. Thus, confirming both literature (Sunstein and Thaler, 2003; Barr and Prillwitz, 2013) and the majority of the respondents, the question might not concern what approach to choose alone but rather how different approaches - using nudging, introducing policy measures and developing commercial services - can complete each other in order to successfully stimulate behavioral changes in the transport sector.

All respondents agreed that in order for people to start travel differently, attractive mobility solutions must be available, fulfilling people's travel needs. Both literature (Redman et al, 2013) and respondents viewed attributes like price, convenience and flexibility as necessary for people to consider not owning a car. Also, attributes such as privacy and status correlating with car ownership 3.2, are seen as factors hindering car owners to break their habits and consider other alternatives. The need for privacy seemed to be an argument against ride sharing, a need that can be met by providing smaller vehicles. This argument is supported by the fact that occupancy rate of car is generally far lower than five people, which a standard car is constructed to fit. Such solution might lessen the pressure on land use, but again increase the attractiveness of the service to such degree that the number of cars will increase. Status connected to the private car was not explicitly recognized as an attribute connected to owning a car. On the other hand, as the integrated services will not be economically available for the majority initially, such services might become a subject of status. For example, carpools that upgrade their car fleet every third year, or similar, probably do so in order to keep the service attractive. It may also done with the purpose of shifting focus from the private car as a status symbol to the service, allowing users to avoid the inconvenience of owning a car, like changing tires or handle insurance.

*Combined mobility*: As 'car owners' is a diverse group and represent a multitude of needs and wants, which is why a single service won't be enough to cover the travel needs of individuals. That point on the importance of combined mobility services. Combined mobility is something that many of the respondent was either involved in, or had concrete plans of performing. All of the service providers at topology level 0 and 1 (see figure 1) have great trust in the possibility that their services can substitute car ownership in some way.

The fact that they embark in multimodal collaborations points towards a perceived advantage in combining their service with others as the demand of mobility is too diverse to be covered by one service. Two respondents referred to younger generations as desiring a new kind of mobility; the possibility of being mobile without owning a car. This increases demands for services that can cover more diverse mobility needs and being flexible. Combined mobility also has great potential for mobility service providers, one example is that a public transport provider can reach new customers through MaaS. This was it becomes easier to be niche specific, which was found to be of interest for public transport providers. Barriers of combined mobility usually include multi-stakeholder collaborations, this was found in interviews as three respondents expressed collaborative difficulties, and in literature (Sarasini et al., 2017a; Jittrapirom et al., 2017). This is a hurdle that can also create trade-offs among value creation for partners and for the environment, which was expressed by a few respondents. In order to overcome these hurdles, creation of a common vision shared among stakeholders can help (Sarasini et al., 2017a). Talking about MaaS, it is regarded as a sustainable type of service, but the question is if MaaS really is a guarantee for sustainable travelling. As, mentioned by one of the respondents, the level of sustainability will depend on the business models used. To avoid indirect effects, the MaaS providers should be very observant on what incentives they aim at creating.

### 5.3 Potential of using persuasive mechanisms

The attitudes among the respondents towards using persuasive strategies to encourage people to change their travel habits was not too enthusiastic. However, results from pilot studies show that persuasive strategies have the potential to contribute to the development of the road transport sector, shifting from an ownership based to service based sector.

*Trialability*: One major problem will be how to convince car owners to actually sell their car(s) and become member of a mobility service. Selling the car could be equated with losing the possibility to control one's life situation independently. Instead, letting people try another mobility service for a while will make them more likely to rethink their transport choice. This is confirmed by Sochor et al., (2017), pointing out low-risk trialability as one important factor affecting users. Thus, trialability of services is important for lessen the resistance towards other means of transport than the private car for the everyday travelling. Strömberg et al (2016) concludes from two Swedish trials that trialability can be a affective strategy to induce radical changes in travel behavior, if applied correctly. Interventions of this type, encouraging car owners to leave the car for a couple of days, have been performed as campaigns, which have shown to be effective (e.g. P5 and P6). It could also be introduction of tickets allowing for flexibility that do not cause any lock-in effect, meaning that the user do not need to commit to continuous usage of the service. The pricing of the service is, as always, affecting the level of user resistance, no matter if it is the price of a subscription or of a single ride ticket. Having low registration fees combined with a pay-as-you-go concept will lower the barrier for trying another mobility service, for instance. Trialability can be promoted by mobility service providers, but also by authorities, and should result in the insight that one does not have to choose between being either a car owner or a user of public transport. It is possible to be both.

*Structuring complex choices and attractiveness*: Many of the respondents had a low trust to the efficiency of persuasive strategies. Yet, mechanisms for structuring of complex choices and to enhance likeability and attractiveness are being used with a non-persuasive intention. These type of mechanisms should not be used alone, as they support the effect of other persuasive mechanisms. The utilization of these brings forward further possibilities of intentional persuasion towards sustainable travelling.

*Competition and challenges*:
Encouraging sustainable travel behavior requires that many different user segments are targeted, to enable any sustainability gains. Therefore, one should not underestimate the variety of persuasive mechanisms that can be applied. Some mechanisms might be encouraging to certain groups, while other user segments need other type of motivations to change their travel habits. For instance, categorizing user segments by age, challenges and competitions could be directed towards a younger segment, $\sim$ 13 to 20 year old's, since the young do not have the same need to manage the ev-

eryday life and everyday travelling' as grown-ups do. Other reasons to why competitions would suit younger better than older user segments, is that younger generations will probably be more susceptible to mechanisms used through an app on their smartphone since they already use it for basically everything else. Thus, the playful nature of these mechanisms could be appreciated. That way, sustainable habits are formed in an early stage which is important as it is those who are young today that will be the ones having high demands on mobility when MaaS services have been deployed. In contrast to that, people responsible for a family and a job might be more interested in the service design and the flexibility that it can offer.

*Goal setting and defaults*:
Goal setting has proven to be a promising mechanism for sustainable travel behavior, according to Denny (2013) and Froehlich et al., (2009). Visualization of a goal makes a person more likely to aim for it, and can be assumed to be as effective in a mobility context as in a sports context. Therefore, using goal setting as a persuasive mechanism has a great potential to increase the likeliness that people choose more sustainable modes of transportation, when applied to combined mobility settings.

Another type of nudge that have shown to be efficient for the purpose of persuasion is default. Just like some restaurants present vegetarian dishes first in their menus (Bacon and Krpan, 2018), environmental friendly mobility options can and should be presented first in a route planner, or similar. For instance, the sorting function in a route planner could have an optional sorting of time and cost, and a mandatory prioritization of environmental friendly means of transport. Such intervention does not force the user to make a certain choice, thus not increasing the resistance to change. Instead it contributes to 'normalization' of the sustainable alternatives by equating these with the private car, which can have an effect on a long-term basis.

# 6   Conclusions

Persuasion through the service itself has shown to be the most utilized way of stimulating sustainable travel behavior. This approach to persuasion is not necessarily the most efficient in order to alter the way people travel. Being aware of the use-

fulness of other persuasive strategies has implications for practitioners to investigate the potential of persuasive strategies. Practitioners, making use of the variety of persuasive strategies and mechanisms, would have the option to reach new users segments and thus attract car owners.

Availability of alternative mobility services is a prerequisite to achieve modal shift. For a mobility service to be sustainable, all dimensions have to be considered meaning that mobility service providers have to take into account all effects, direct and indirect, of their services. Therefore, only proving such service will not be enough for the road transport sector to become sustainable. Service providers have a high awareness of environmental aspects, however, it can be seen that the social implications of their services are being underestimated, and that indirect effects might be overlooked or even ignored. As this seem to be common among practitioners it is of great significance that mobility service providers contemplate what incentives that they aim at creating, and in what purpose this is done. Further, policy interventions is needed to emphasize inclusion of all dimensions, for long-term sustainability.

A common reasoning among the respondents concerned the irrelevance of persuasive strategies to stimulate behavioral change. There are implications for research to conduct more studies on the subject of persuasion in mobility contexts, as it can be seen to have potential. The lack of knowledge and trust to the subject among practitioners is a barrier for further integration of persuasive mechanisms in mobility services. Most respondents showed reluctance towards deploying strategies that they did not know would work. Long-term studies where novelty effects can be ruled out are needed in order for practitioners to be willing to invest in implementation of persuasive strategies.

As shown by Strömberg et al. (2016), trialability is a key factor for individuals to start rethink their travel habits. Practitioner participation in pilot projects is necessary for expanding the base of knowledge about the effects, positive and negative, connected to application of persuasive strategies. That may however constitute a risk for mobility service organizations in terms of uncertainty of cost and and outcome. Therefore, practitioners may need a push from policy allowing for trialability while also getting higher requirements on contributing to sustainability within the sector.

As stated by Henriksson et al. (2011) when measuring the effects of congestion pricing introduced in the Stockholm area, implementation of policy measures has shown to have a direct effect on behavior. This implies that the combined efforts through policy implementation and practitioner action guided by research, will be necessary for stimulating sustainable travel behavior.

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# A   Data base searches

| SCOPUS | | | |
|---|---|---|---|
| Query string | Number of hits | Query string | Number of hits |
| KEY( "gamification" OR "gameification") | 2515 hits, of which 4 of the first 20 articles was chosen among the most cited. | KEY ( "Impact categories" AND ( transportation OR "car traffic" OR cars OR "public transport" ) ) | 2 hits, 0 relevant. |
| KEY ( "gamification" OR "gameification" AND ( mobility OR "smart city" OR transport ) ) | 39 hits, of which 6 seemed relevant among the most cited. | Query string: KEY("Impact categories") | 91 hits → too many. Use other search engine to find transport related articles. |
| ( "sustainable mobility" AND "persuasive" OR "persuasive technologies" ) | 4 hits, of which 3 seemed relevant. | KEY("ozone" AND "cancer") | 723, of which 1 (next highest cited) seemed to be relevant among the most cited. |
| ( KEY ( gamification OR gameification ) ) AND ( "urban transport" ) | 3, hits, of which 2 seemed relevant. | KEY ( lca AND "public transport" ) | 12, of which 1 (next highest cited) seemed to be relevant among the most cited. |
| KEY ( "sustainable travel" OR "sustainable travels" AND ( beahviour OR behavior ) ) | 13, hits, of which 3 seemed relevant among the most cited. | KEY(Acidification AND causes) | (320+4498), of which 1 (next highest cited) seemed to be relevant among the most cited. |
| KEY ( "mobility service" AND "sustainable behavior" OR behaviour ) | 9 hits, of which 3 seemed relevant among the most cited. | TITLE-ABS-KEY ( concentration AND fish AND aluminium ) AND ( LIMIT-TO ( SUBJAREA , "ENVI" ) OR LIMIT-TO ( SUBJAREA , "AGRI" ) OR LIMIT-TO ( SUBJAREA , "BIOC" ) ) | 782 hits, of which 2 were chosen among the most cited. |

| | | | |
|---|---|---|---|
| TITLE-ABS-KEY ( green AND defaults AND nudge ) | 5, of which 1 seemed relevant. | KEY ( attractiveness AND persuasion ) | 10 hits, of which 1 (not the most cited) seemed to be relevant among the most cited. |
| TITLE-ABS-KEY ( choice AND architecture AND sustainable AND mobility ) | 13, of which 1 seemed relevant among the most cited. | KEY(design AND persuasion) | 164 hits, of which 1 seemed to be relevant among the most cited. |
| TITLE-ABS-KEY ( Persuasive AND technologies AND sustainability ) | 101, varav of which 1 seemed relevant among the most cited. | KEY(flattery AND persuasion) | 3, of which 1 (the most cited) seemed to be relevant among the most cited. |
| ALL ( ( behavior OR behaviour ) AND change AND "mobility service" AND sharing ) | 68 hits, of which 7 seemed relevant. | TITLE-ABS-KEY ( "car use reduction" ) | 54 hits, of which 4 seemed to be relevant among the most cited. |
| ALL ( "Green default" ) | 128, however, no new relevant articles were found - the purpose was to find more information on green defaults and its applications. | KEY(acidification AND ocean AND "carbon dioxide") | 1347 hits, of which 2 seemed relevant among the most cited. |
| KEY(Nudging) newest and most cited | 289 hits, of which 3 seeed to be relevant among the newest and the most cited. | KEY (accessibility AND sustainability) | 288 hits, of which 3 seemed to be relevant among the most cited. |
| KEY ( "Price models" AND "behavioral change" AND transportation) | 0 | KEY(accessiblity AND transport AND sustainability) | 268 hits, of which 3 seemed to be relevant among the most cited and 1 of the newest. |
| KEY(equality AND transport) | 31 hits, of which 4 seemed to be relevant among the newest. | KEY ( "business model" AND "mobility service" ) | 10 hits, of which 3 seemed to be relevant among the most cited. |

| | | | |
|---|---|---|---|
| KEY ( "Sustainable transport" AND safety ) | 41 hits, of which 2 seemed to be relevant among the most cited. | KEY ( "business model" AND "urban mobility" AND accessibility ) | 0 |
| KEY ( "urban transport" AND safety AND sustainability ) | 11 hits, of which 3 seemed to be relevant among the most cited. | KEY ( "business model" AND mobility AND sustainable OR sustainability ) | 18 hits, of which 3 seemed to be relevant among the most cited. |
| KEY ( safety AND crime AND transport ) AND ( EXCLUDE ( SUBJAREA , "MEDI" ) OR EXCLUDE ( SUBJAREA , "NURS" ) OR EXCLUDE ( SUBJAREA , "BIOC" ) OR EXCLUDE ( SUBJAREA , "AGRI" ) ) | 30 hits, of which 4 seemed to be relevant among the most cited. | KEY ( "business model" AND "multi modal" OR "inter modal" AND urban ) | 0 |
| | | KEY ( "business model" AND "urban transport" ) | 4 hits, of which 2 seemed to be relevant among the most cited. |
| **Science Direct** | | **Chalmers Library** | |
| green default | 54 000 hits, of which 4 seemed to be relevant. | Green Default | 397,546 hits, of which the second listed seemed relevant. |
| **Google** | | | |
| Markanvändning städer | 2 hits seemed to be relevant (report from SCB and from Trivector for The Swedish Transport Administation) | Nationella mål trafiksäkerhet | 1 hit was relevant (report from The Swedish Transport Administation) |

Due to an obvious lack of literature regarding impact categories and transport, a search was done through Google: Impact categories transport, which resulted in the report "Environmental impact from different modes of transport- Method of comparison".

Following, another search via Google: "environmental factors in the transport sector", resulting in the report "Transport, Environment and Health" from WHO, and a report from OECD; "Towards greener households - transport", part of a study concerning Household Consumption (EPIC).

# B  Interview questions
## Interview questions about sustainable travel behavior

**Background**

This study is performed as a master thesis via Chalmers and RISE Viktoria in Gothenburg. The study examines sustainable travel behavior in urban areas and how such behavior can be stimulated by providers of mobility services, such as carpools, public transport or similar. We examine the possibility that mobility services can influence customers towards 'greener' modes of transport, reducing emissions and other negative effects. We also look into what can make people avoid travelling by car in favor of other mobility services.

We would like to know how you and your organisation are trying to encourage sustainable travelling and what types of incentives that are created for that purpose. Further, we are interested in your view on sustainable transportation.

Our aim is to answer the following research question:
- How do existing mobility service providers create incentives for sustainable travel behavior in different type of MaaS services?
  (MaaS = Mobility as a Service)

**Background Questions**

1. We have looked at your service/website and and see that your service is…… and aims to ……, and that you are …... . Is our understanding correct?

**Sustainable road transport**
Sustainability is usually defined by having three dimensions or 'pillars' that it relies on; namely economic, ecological and social dimensions. The transport sector contributes to many detrimental effects to the environment, the most known are emissions of $CO_2$ and other particles, but it also causes acidification, land use changes and elevated risks to human health. Transport affects social and economic sustainability through factors such as equality, accessibility and road safety.

2. In your opinion, which of the issues we just mentioned (or others) are the most critical to the sustainability of the road transport system?
   a. And how does your service tackle or contribute to these issues?

3. Is you service used as a complement to private car or does it serve as a substitute?

4. In our literature study, we have identified a few factors that makes private cars attractive, such as convenience, flexibility and time efficiency. How does your service

compete with car ownership?

5. Your service was offered as … (look up their price model). What effect do think this may have on the travel behavior of your customers?
    a. What sustainability effects do you think this might entail?

6. How do you try to encourage sustainable travelling?
    a. What sustainability effects do you aim at fostering?
    b. Is there any sustainability trade offs within your service?

**Persuasive strategies**
Strategies that are used to influence behavior are often referred to as *persuasive strategies*. In the context of influencing travel behavior we have identified three main groups of strategies; nudges as persuasive strategies, gamification and price models. Nudging and gamification aim to influence or stimulate a target behavior. Most of these features are applied in mobile apps. For example, a MaaS-provider can set up a competition where users compete for rewards (e.g. use of a Tesla), by choosing environmentally friendly modes of transport.

7. One category of *persuasive strategies* is to create positive incentives and accountability through goal setting, self monitoring and rewards for desired behaviors. Rewards are often given when users complete some sort of challenge. Do you apply any of these strategies? With what purpose?

8. Likeability and attractiveness of a system are important in order to persuade users. The system can appeal to users by using a voice of authority, being verifiable and trustworthy, to take the part of a character when communicating with users, or simply being visually appealing. What such features are applied in your app/platform? What purpose do they serve?

9. When users face complex choices, there are opportunities of persuasion when helping them structure the alternatives. Some examples are route planners that remember user preferences, simulation of CO2 emissions or tailoring route suggestions based on context. Do you apply any of these strategies? With what purpose?

10.  Another approach is to use the social nature of people to persuade them, for example to include information of other users' behavior in comparison purposes, to allow users to compete between each other or collaborate in teams. Do you include any such features? With what purpose?

11. Default settings is another way of influencing users. An example of this is that 'green' modes of transport will show at the top of every search in a travel planner. Do you

apply any default settings in order to influence your consumers? With what purpose?

12. What effect do you think the use of features, like the ones mentioned above, may have on travel behavior and on sustainability?