Sustainable Urban Mobility

Could smartphone apps master the challenge…?

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Abstract

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If Europe is to meet its Kyoto commitments and avert further environmental damage and climate change, urban car traffic has to decline drastically. Yet, no efforts to master the challenge have succeeded. Planners need new demand side tools to help facilitate more sustainable travel patterns and increase use of public transport. This thesis is a literary contribution to the EU SUNSET and Swedish ISET projects, discussing virtual networking and smartphone apps as potential solutions. The issue requires a transdisciplinary approach. I analyse the policy framework of Mobility Management, review urban travel statistics in Europe and Sweden, and consult behavioural theories from psychology, sociology and economy. I also study app technology and the existing market. I find travellers' budgets to be primarily guided by habits and subjective perception of relative time and convenience, rather than factual time or money. The most important incentives for choosing public transport are; maximised effective time, structural improvements and convenience to daily chores. From this, I outline app features that could rationalize decisions and simplify non-car based travel in the cities. Primarily by enabling a portable workplace and attract the key car driver group – habitual, middle-aged, working men. I also list empirical surveys that could make my findings more generalizable. I conclude that apps can support sustainable development in urban traffic, especially amongst young, but only if combined with supporting structural and political strategies and implementations – a whole new collaborative mind-set.

Keywords:
Sustainable development, public transport, urban traffic, smartphone apps, SUNSET, Mobility Management

Abbreviations:

Eurobarometer	EB
The European Platform on Mobility Management	EPOMM
Greenhouse gas	GHG
Information and communication technology	ICT
Innovation for Sustainable Everyday Travel	ISET
Mobility Management	MM
Swedish Institute for Transport and Communications Analysis	SIKA
Sustainable Social Network Services for Transport	SUNSET
The National Travel Survey	RVU
Quick Response	QR

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1. Introduction

1.1 The sustainable travel challenge

Increased fuel taxes, congestion charges, green urban planning, ambitious political emission commitments or researchers' continuing alarms of climate change – nothing seems to overcome the passenger car's firm grip of European cities. 75 % of the growing European population live in urban areas and 75 % of their journeys are done by car (EEA, 2011a, EurActiv, 2009, Eurostat Press Office 2008). The car symbolizes a basic necessity and has a given place in urban infrastructure. This structural car-dependency results in heavy congestion even in smaller cities and an increasing impact on the environment and the climate through emissions of greenhouse gases and particles. Urban mobility contributes to 40 % of transport CO_2 emissions in Europe and 70 % of other transport pollution – an overwhelming obstacle for the EU that works to fulfil the Kyoto 20-20-20 commitments[1]. The short car trips in urban areas are meanwhile theoretically easily converted to alternative modes, such as public transport, and have the largest potential for emission mitigation policies (European Commission, 2011a and b).

1.2 Political objectives to bring about change

The European Commission *Transport White Paper* (2011) establishes 40 initiatives to reach sustainable transport goals, e.g. to cut CO_2 emissions in European transport by 60 % by 2050. The White Paper is a roadmap on how the EU and its Member States are to work towards a "competitive and resources efficient transport system". Topics of discussion include the challenge to increase sustainable travel in the EU through legal regulations, if to avoid distortion of competition between transport modes. Instead, innovation is called for and information technology in many aspects discussed as a tool. The need to combine policy instruments to is emphasized; that structural changes in urban forms have to be combined with regulative efforts and information technology (EurActiv, 2009).

Sustainable travel is one of the indicators of the European Commission's (2011d) Climate Action, as well as part of national objectives such as the Swedish Environmental Targets (Swedish EPA, 2011b). Creating a clean urban environment is also a priority in the renewed Lisbon Strategy (EurActiv, 2009). The goals of sustainable urban traffic coincide with ambitions of attractive cities, which usually have restricted car transport in the city centre, people

[1] The EU-27 has committed to the Kyoto Protocol (1997), to reduce their aggregated GHG emissions by 20% by 2020 (EEA, 2011 and UNFCCC, 2011).

in motion and a well-functioning public transit. Releasing parking lots is also interesting considering that the growing urban population requires more free space for housing and a functioning and sustainable infrastructure.

A range of management instruments are available and used in the aim towards a more sustainable traffic system. City planning and infrastructure is optimized to facilitate transport flows, economic incentives such as taxes, grants and congestions charges are implemented and urban pollution restrictions applied. Modern vehicles separately result in fewer emissions through technical advances, and renewable fuels are gaining market shares. The continuously expanding car fleet and increased travel volumes however still result in a rebound of steady net-increase of environmental impact, and the situation is getting increasingly alarming. There is a need for demand side instruments, such as provided by Mobility Management frameworks, addressing the mobility demand and encouraging people to think twice about their travel (section 2). Nevertheless, how to permanently alter urban travel behaviour and reduce harmful emissions continues to be the recurring question for planners and developers.

1.3 The need for complementing measures

The International Association of Public Transport (UITP) states that *"We need to reduce the volume of traffic. Technology alone cannot provide a solution; we have to change people's behaviour too"* (EurActiv, 2009). Arnestrand (2011) at the Swedish coordinating traffic company Samtrafiken argues that public transport and other sustainable modes of mobility have to become the norm by a change of mind-set. Public transport needs to be the automatic solution rather than the car, and transformed from being the complicated alternative to the easier choice. This thinking is popular in urban planning, but can be used also for information flows. One example is the cooperation between Samtrafiken and Google Transit, where the road description offers either car or public transport on the same level of choice, and not car by default (Arnestrand, 2011).

The EU project Sustainable Social Network Services for Transport (SUNSET)[2] is developing methods exploring how this thinking can be stimulated. How social media can be used to build contacts with and between everyday travelers, to promote use of public transport and a sustainable European transport sector. For certain trips, the car is an unavoidable necessity, and the initial aim is foremost to encourage alternative transport as far as possible. The project promotes alternative transport modes by developing smartphone applications – *apps* – for

[2] http://www.sunset-project.eu/

travelers e.g. in order to find bus lines, -departures, or to get in contact with each other as a conscious social group (SUNSET Project, 2011). The project is further investigating what incentives the travelers ought to be provided with to leave the car more often and how these shall be designed in terms of easily accessible, operative interfaces (SUNSET Project, 2011).

Innovation for Sustainable Everyday Travel (ISET)[3] is a similar regional project in Western Sweden, stretching over three years, where the aim is to increase sustainable everyday travel in the region through a physical and virtual meeting place. Here, public transport authorities, private service companies and research organizations jointly work to develop the future digital services for everyday travelers (Viktoria Institute, 2011).

1.4 Problem and aim

My thesis is a literary contribution to the SUNSET and ISET projects, discussing how incentives can be designed to make the urban European traffic more sustainable, based on cognitive and alternative economic theories of human behaviour, and empirically identified travel patterns. My thesis focuses on the hypothesis that smartphone apps' might be successful as innovative policy instruments to change mobility patterns – a new and unexplored research angle.

Smartphone apps are revolutionary tools to reach the public and develop interaction amongst groups, with advantageous usability, simple interface and unique adaptability to the individual user. Apps are already frequently used within the transport and infrastructure sector for both Android and iPhone platforms (5.3), but travel patterns are a matter of human psychology, deeply rooted routines, family constellation, globalisation and our increasingly hasty way of life. Not easily changed.

In the strive towards more sustainable urban travel patterns, I seek to answer the following questions;

- Can smartphone applications support this development (and to what extent)?
- What incentives would attract users, and make rational motorists chose public transport more often?
- What functions and designs would make them successful?
- What conditions could affect the apps' success?

[3] http://web.viktoria.se/iset/

2. Method

This paper is based on a practical transdisciplinary method described by Max-Neef (2005). Transdisciplinarity is required in this thesis since the issue of unsustainable transport development, like most global environmental and sustainability issues, is unmanageable from one disciplinary angle only. My model, illustrated in figure 1, is composed of a pyramid of hierarchical levels; the base consists of *what exists* – the empirical laws and principles of nature, called logics. The next level is pragmatic, or *what we are capable of doing* in a strictly technical sense, followed by a normative level of planning – *what it is that we want to do*. The top of the pyramid asks *how we should do what we want to do*, problematizing a utilitarian aim of the issue in regards to the whole planet as well as future generations (Max-Neef, 2005). I use the method model to identify the logics and technical possibilities in three particular focus spheres relevant for answering my problems (Figure 2). Then, I use this to discuss the planning (third) level and how to pursuit the aim of sustainable development in the top level.

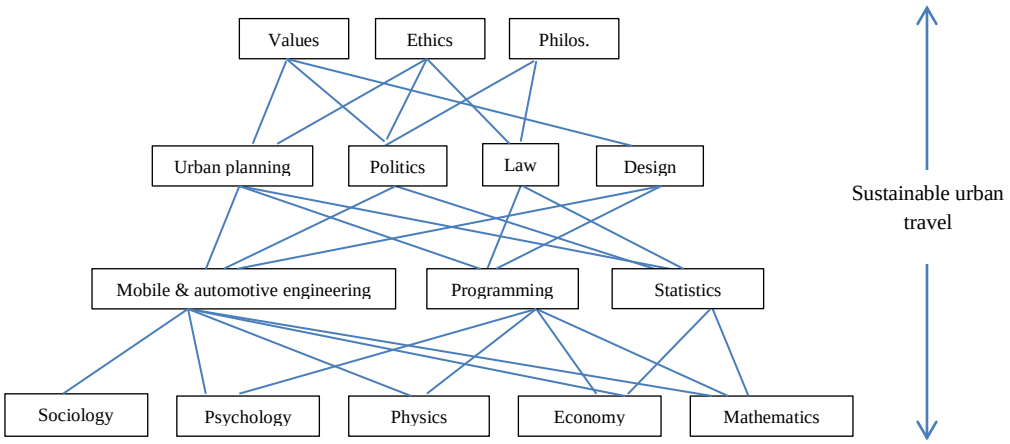


Figure 1 The transdisciplinary nature of sustainable urban travel. Graphics modified from Max-Neef's model (2005)

I approach the problem from three spheres – Mobility Management (MM), the traveller and his/her willingness to change and transport facilitating apps and their potential (Figure 2). My hope is to be able to locate solutions intersecting all three spheres, thus suggested to be most sustainable. A solution that is technically possible in the app today, desirable or sought by MM and not to forget is wanted by the traveller. My arrangement is much like a classical hypothesis testing, but my budget in terms of time and money has not allowed me to see the empirical testing through. To statistically test the hypothesis that smartphone apps can be successful in changing travel behaviour, I suggest my concluding survey recommendations in section 6.1.3 are realized and the results used as test data.

Figure 2 Schematic sphere approach

2.1 Mobility Management

I start my results by describing Mobility Management (MM) as the primary policy framework for demand-oriented infrastructural management, an example of what is strived for in level three, Figure 1. I use a version of systematic meta-analysis, where the data and facts are gathered through a literature study. I describe the Swedish Transport Administrations policy framework, *the four-stage principle*, as an example of how hard and soft measures can be translated into the SUNSET and ISET objectives of sustainable urban travel. I further review what MM experiences from transport agency documents can reveal, and strategies of how to sell increased sustainable travel behaviour to urban travellers and policy makers.

2.2 The traveller

In my description of the traveller, I use foremost Swedish statistics of urban travel patterns, and European figures were available in order to provide a macro level and deepen the basic foundation of the paper. Again, I use a systematic meta-analysis to provide me with tools to

make a transdisciplinary study (Figure 1). The primary quantitative data is largely based on the latest Swedish National Travel Survey (RVU), RES 2005-2006, the European statistical database Eurostat and Flash Eurobarometer (EB) report (2007). These statistics are the pragmatic tools (level two, Figure 1) to understand the basics of human behaviour (first level, Figure 1). RES gives statistics on how the Swedish population in ages 6-84 years travel on a daily basis. The survey was carried out through telephone interviews under the responsibility of the government agency Transport Analysis (2011a). Eurostat is the statistical office of the European Union, providing objective statistics of the Member States that enable comparisons between countries and regions (Eurostat, 2011a). Flash EB (2007) is a Gallup survey covering all 27 EU Member States on a randomly selected sample of 25 767 individuals over 15 years of age. Other quantitative data is described closer in Table 3, appendix 1.

With take-off in different disciplines (first level, *logics*, Figure 1), I synthesise main human context-dependent barriers and incentives relevant for urban planning and the app technology. I also look at stated preferences found in previous empirical material. The material is gathered from dissertations, articles and books either recommended by branch professionals or browsed through Internet based databases (Table 4, appendix 2). The barriers are identified in order to improve the understanding of human travel behaviour and incentive structures in a sustainability aspect and in order for me to make suggestions to how these barriers can be overcome in the SUNSET and ISET project.

2.3 Transport facilitating apps

My view of app technology within the second, pragmatic level (Figure 1) serves as an insight to what is plausible today. This is made through a systematic literature review of the most recent studies and articles on behavioural impact of smartphone apps, at the time of writing. The examples and material are identified by browsing databases and talking to branch professionals, thus primary secondary data (Table 4, appendix 2). General *do's and don'ts* in app development are presented; second level pragmatic data, guiding what is sought in the third level (Figure 1). I further consider a potential consignor of the information and the possibilities of using smartphone applications as messengers of political aims and the potential of innovation in the field. I also list a selection of solutions already available on the Swedish market to endorse my concluding suggestions. Finally, I discuss alternative potential of new instruments made available by mobile technology.

2.4 Boundaries, definitions and limitations

Within the scope of the SUNSET and ISET projects, I focus entirely on urban everyday travel in the EU, with Sweden as a specific example. I make the assumption that the Swedish statistics are a plausible case study. I have further defined *everyday travel* as work- and school commuting, public transport travels, and transport to daily chores such as shopping trips, and s*ustainable travel* as reducing the share of passenger car travel in favour of e.g. public transport with low environmental impact (Lund Municipality, 2007).

I am aware of limitations of my method and scope, which are due to the limited time and budget of a 15 ECTS thesis. I recommend that the suggested surveys in section 6.1.3 are adopted to improve the generalization and certainty of my findings. Due to the same restrictions, I have chosen to focus primarily on literature found through the Lund University library database (LibHub) and recommendations. Additional disciplines and theories are likely to be interesting in the next step, as well as future articles on app technology since the development is fast. The reader is directed to literature in each field respectively for such material. Thirdly, I chose to use Sweden as a case example in Europe, due to my access to Swedish data and the lack of detailed European statistics. However, the RVU data from RES 2005-2006 might already be outdated, since the Swedish road transport is increasing continuously. It is likely that the travel patterns identified are even more profound, or different, in 2012. This thesis ought to be followed up after conducting the section 6.1.3 surveys and with access to more recent RVU's.

3. Mobility Management – how to manage demand

The passenger car sector has, as said, the largest potential for GHG emission cuts in Europe (Johansson, Eklöf and Karlsson, 2010), but available policy instruments have not nearly overcome the unsustainable traffic development. The car has largely influenced how our cities are planned, and today most new establishments require car access (Ljungberg, 2003). We see a lucrative environment for sub-urban development, car sales and urban sprawl, but a nightmare for those seeking to develop future sustainable traffic systems.

To create a more sustainable traffic system, meet political climate commitments and avert further environmental degradation, the planning of society, infrastructure, as well as the policy mind-set needs a new, more holistic perspective. Ljungberg (2003) discusses the importance of integration of different disciplines in urban planning and an open dialog. Methods and modes of operation to support such work are e.g. the four stage principle, demand side measures and Mobility Management.

3.1 The four-stage principle – a transport strategy

The Swedish public transport industry has a target of redoubling the number of public transport travels to 2020 (Johansson et al., 2010). The Swedish Transport Administration has an important role to play with its general strategic framework, the four-stage principle: (1) influencing demand and travel mode, (2) more efficient use of existing infrastructure, (3) limiting reconstructions, and least desirable (4) new investments and construction. The two latter are mainly hard measures such as increased energy efficiency in vehicles and infrastructure, renewable fuels, urban planning, commuter parking etc. Further examples are CO_2 tax, congestion charges, eco-driving and regulated tax imposed on fringe benefits (Johansson et al., 2010). Taxes are difficult to use on a local/municipal level however, according to Lund municipality (2007), and are foremost tools for higher political levels. Even on a national level are taxes unwieldy instruments, since they have to be strong to achieve sufficient environmental relief. Furthermore, political intentions are often to get re-elected, and these measures might thus be considered unattractive.

The first two steps are so called soft measures, where Mobility Management (MM) is an instrument. MM deals with the need and demand of transport and tries to optimize the necessary travel in a sustainable way, and reduce unnecessary travel. MM can be seen as the software (influencing behaviour and knowledge) that improves the performance of the hardware (structural, hard, measures) (Mobilitymanagement.se, 2012). Johansson et al. (2010) means

that MM measures such as car pools and teleworking (working from home), have the potential to increase public transport travel even more than double. Ljungberg (2003) mentions Swedish research from Lund, showing that the combination of MM and physical improvements to the public transport system can have considerable effects on car traffic. The aim is to change travellers' attitudes and behaviour through communication and information, a method used all over Europe (Ljungberg, 2003). ICT technology is extensively used in this work, e.g. in teleworking-tools. The area has large additional potential to be explored and additional and effective ICT tools are needed to try to change travel behaviour. Are apps potential success stories?

4. The traveller – mobility and travel behaviour

4.1 Travel patterns and key socio-demographic groups

Management to make traffic more sustainable is best aimed primarily at the dominating traveller groups (European Commission, 2011b). The group that never or seldom chose alternative transport has the largest potential to achieve environmental relief with a new behaviour. In app technology, the user solely chooses which apps to download and what information to be exposed to. The ones most likely to download the app can therefore be assumed to already have a certain interest in sustainable travel of different reasons. In order to attract motorists that do not have any prior interest in public transport – the true challenge – good awareness of their habits, needs and objectives is essential. The statistics below helps to identify these key socio-demographic groups for the SUNSET and ISET objectives.

4.1.1 General urban travel patterns

Modal split in larger Swedish cities is 41 % car and 32 % public transport, and the use of public transport declines drastically with the falling degree of urbanization, where the supply is less developed (SIKA, 2007). Travel with public transport has increased 19 % during the last decennium (Transport Analysis, 2011c), and about one third of Swedes in ages 6-84 years have some kind of discount card (SIKA, 2007). The urban trips are the shortest in Sweden, but take the longest time (Figure 3). Petrol is the dominating fuel, used about eight times as much as diesel. Alternative fuels are used to a miniscule extent. The European Platform on Mobility Management (EPOMM, 2011) provides detailed information of the modal split in European cities individually, but is not covered here.

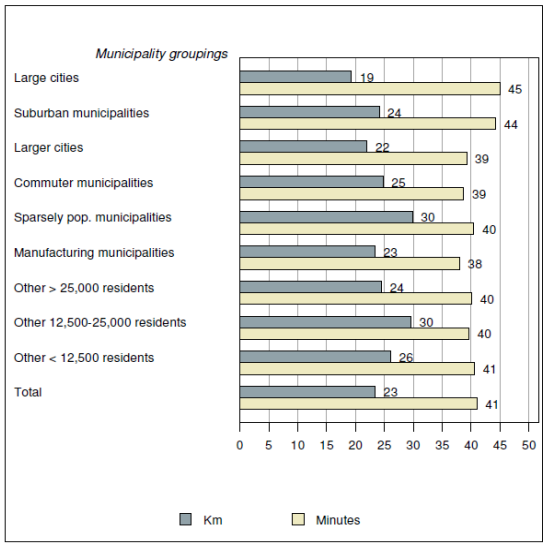


Figure 2 Travel time and distance traveled for journeys by region (SIKA, 2007)

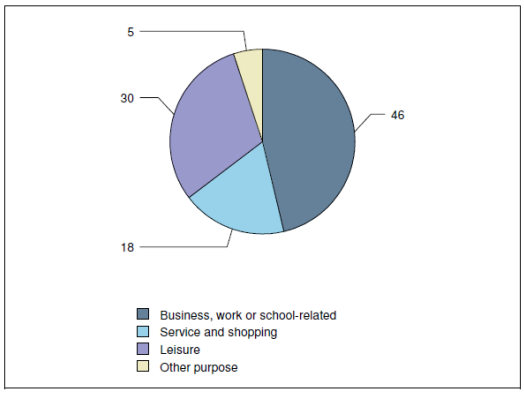


Figure 2 Allocation of journeys (%) by purpose . The whole of Sweden (SIKA, 2007)

A majority of journeys to work in Sweden are made by car (Figure 4), 41 % in large cities and 62 % in medium-sized. 30 % of these are less than 5 km according to the Swedish Transport Administration (2006). Both the route and time of day for work trips generally follow a regular pattern. Professionals are thus an interesting group, also because work commuting vehicles are badly utilized – 86 % of travels to and from work/school are done with one person in the car (SIKA, 2007). For leisure trips, only 33 % travel alone. The group of professionals is assumed to range from 16 – 65 years of age. In Europe, mobile phone use in this group is over 95 % which potentially opens up for mobile based mobility incentives (Table 5, appendix 3, Eurostat, 2011c).

4.1.2 Gender, age and travel patterns

SIKA (2007), states that men and women travel for about as long time per day. Men travel more often by car, 47 versus 31 %, and farther distances. In ages 18-84, 82 % of Swedish men have a driver's license and access to a car, 12 percentage points more than women in the same group (SIKA, 2007). Owners and drivers of cars in Europe are mostly men aged 25-54, highly educated, employed and rural citizens, while urban citizens, women, young and non-workers are less frequent car owners/drivers (Flash EB, 2007).

Frequent Swedish travellers are of ages 25-34 years and fulltime employees. Older people travel far less than other age groups (SIKA, 2007). Carlsson-Kanyama, Lindén, and Thelander (1999a) suggests in a Swedish case study that this is a result of up-bringing and travel experience, and that preferences for travel patterns are shaped early in life. The coming generations of older people will therefore probably want to travel more than today's old, and considering the rising volumes of older age groups in Europe and if they adapt the prevailing modal split, this poses a further sustainability concern (European Commission, 2011c). However, when older travel; they are often obliged to use public transport due to physical reasons and lack of drivers licence (Transport Analysis, 2011b). Over half of the European age group 65-74 years interestingly have a mobile phone, and this share is likely to increase in the future (Table 5, appendix 3, Eurostat, 2011c).

Journeys are often divided into side-trips and errands – deeply rooted habits based on household composition and location. When coordinating daily trips to school, work, shopping, leisure, medical care etc., the car is often considered the only sensible option. The development of sub-urban shopping malls and urban sprawl induce further car-dependency for these errands. Men and women make about as many errands, although women more service related

ones and men travel somewhat more in work (SIKA, 2007). One obvious side trip for both men and women in their mid-ages is to drop off children at school. The typical everyday errands for the typical household might be sensible to compile through an empirical survey, in order to optimize the app according to these patterns.

4.2 Compilation of general traveller preferences – the trip

Motivation behind how we prioritize and chose travel mode is based on specific attitudes towards each aspect of the trip. These incentives are subjective and differ between individuals, but can be generally portrayed as follows, according to transdisciplinary theories trying to explain empirical laws (first level, Figure 1):

- *Rationality*: people act rationally based on their own perspective, influenced by experience, ideological conviction and the behaviour of others (Larsson, Bratt and Sandahl, 2011). Most economic theories depict the individual as rational in some degree. According to the present economic paradigm, neoclassic economic theory, consumers are fully rational and free – Economic Men – seeking to optimize their personal satisfaction in each situation. Institutional and behavioural economics criticise this static view of man, and gives a more subjective explanation of how people behave, and emphasize the role of institutions and the normative and regulative rules in society. Institutional economics studies what influence consumers' choices apart from prices, e.g. time and comfort in the case of travelling. These theories are based on how people empirically act and interact on the market and the importance of social networks and capital, trust, fairness, democracy etc. Ecological economics, finally, take the theorem of human behaviour even further and sees man as multi-dimensional with different roles, relations and activities between which we seek rational concurrence through our actions.
- *Costs and benefits*: according to neoclassic theory, individuals act to maximize benefits and minimize costs without influence of values or subjective attitudes. Each decision is said to be backed by optimal and maximal information and with all alternatives at hand (Larsson et al. 2011). Economist and journalist Tim Harford (2008) agrees in his book *The Logic of Life* that people are rational, but that we meanwhile respond to incentives, consider consequences and have sound motives for our actions. When something becomes more costly to do, people will tend to do it less; and the other way around. Rational decisions, he says, are based on these trade-offs of lowering costs and raising benefits that influence the total personal budget and future consequences. The budget is not

purely monetary or short-sighted, but consists of different means to achieve personal objectives, such as time, effort and attention – or mobility in this matter. People tend to spend most time within their comfort zone built of habits and known environments, where they make less mistakes. What ultimately influences our actions seems to be this – our life sphere – the world we understand, know and care about. There, most people want to do good and ensure wellbeing for their social company, their home area, their local natural habitats, their workplaces etc.

- *Values and attitudes*: in sociology literature, Krech, Crutchfield and Ballachey (1962) states three general ground elements shaping our values and attitudes: *affective (emotions)*, *cognitive (knowledge)* and *conative* (*readiness to act)*, which each consists of a complex of qualities. The emotional element is linked to knowledge, ranging between like and dislike, and indicating the importance of positive information rather than deterrent or negative. According to Anna-Lisa Lindén (2004), professor emerita at the Dept. of Sociology at Lund University, the knowledge element can be theoretically or practically vested, where the latter is more easily developed into behaviour and the theoretical knowledge is faced by a translation problem in how to apply the known into action. In this case, if you are brought up with a frequent use of public transport, you are more likely to adopt that behaviour, than if you read about the environmental benefits of public transport. This has been suggested empirically in a number of successful public transport trial periods projects, e.g. the Swedish transporter Västtrafik, where 28 000 motorists in 2010 were offered a test travel pass, with the ambition to get 20 % new customers at the end of the trial period. The outcome excelled the expectations – 30 % of the test group became new frequent customers from testing the behaviour (myNewsDesk.com, 2011). It was not stated however whether the changes were long- or short term. The third component, readiness to act, concludes what the person says to be willing to actually do on the scales of active – passive and support – revolt (Krech et al., 1962). The readiness to act is high for actions where we feel that our own efforts can be effective, and where the act is as simple and painless as possible. E.g. we are more inclined to change a light bulb to ease our environmental concern than to reduce our car travel.
- *Motivation to act*: the value elements above add up and we act to realize a lifestyle as close as possible to our ideal image, but there are still important differences to how we actually behave. When the relation between the three does not conform, a dissonance arise that we seek to adjust (Festinger, 1957). E.g., a person who feels that driving a car

to work not correlates with his or her environmental values might adjust the dissonance by either taking the bus, reason that the own behaviour has little impact on global issues, or perhaps argue that a car is a right and the state should deal with environmental problems. The dissonance thus creates motivation to act, and though each method to solve this dissonance is subjectively rational, it might be problematic in a utilitarian perspective such as global climate issues. It is often difficult or impossible to foresee the consequences of ones actions in the bigger picture, especially concerning environmental and sustainability issues.

The classical psychologist B. F. Skinner (1953) said that positive (application of stimuli) and negative (removal of aversive stimuli) reinforcement shape and control our behaviour. Through these rewards or "punishments", we alter our behaviour so as to ease the costs and maximise the benefits of our actions. In global environmental systems, we are not subject to any direct contextual reinforcement stimuli – the effects are often long-term and comprehensive, making acting according to what is best for the environment a challenge. We are more prone to act according to closer and more substantial incentives. Sustainability is thus a generally weak argument for not driving a car.

- *Relative time*: the preference of short travel time seems to be a fruit of subjective understanding. Rationality has less importance than perception – it is foremost the relative time difference between modes or alternatives that is considered. Time preference is not static or exclusive however; its value is toned by other preferences such as convenience and comfort (we chose the longer car trip over quicker bus trips, due to its perceived outperforming comfort benefits, freedom etc.). Individuals value time differently, depending on circumstances e.g. spending time waiting on a platform or in motion whilst travelling.
- *Freedom of choice*: if assuming that the empirical findings discussed in section 4.4 are generally applicable in urban travel patterns, a central incentive behind many aspects of travel preference is freedom of choice: freedom to choose travel time, -route, -destination, and to be mobile at will. A car is generally perceived as the ultimate way of providing this independence.
- *Security and habits*: behavioural economic theories say that we use rules of thumb and habits to simplify our decisions, and spare us explicit choices when we try to accommodate our narrow contextual needs (Larsson et al. 2011). We generally seek concurrence and routine in our daily lives and to stay within our comfort zone where what we expect

is also what is given to us. Predictability and security is especially important in travelling. Since we are in control whilst driving, it is easier to foresee the expected outcome in a car than in a public transport vehicle where we simply tag along. In public transport, external information such as time schedules is needed; an insecurity intruding on our habitual comfort zone. Motivation behind travel patterns is much shaped by habitual everyday scheduling and combined errands. Habitual travel patterns often involve several family members and are thus complex, making them difficult to influence. Larsson et al. (2011) also emphasises the human characteristic of comfort-seeking, where we try to get as much as possible out of as little effort as possible.

When pursuing long-term sustainable travel behaviour all these cognitive and economical trade-offs are important to unite, both quantitatively and qualitatively. Through information and awareness, the personal life sphere can be widened and come to include a more holistic protective value both in terms of ideals and other people. Below follows a synthesis on what has been found empirically to particularly impact our choices of transportation – offering an indicator of what aspects to consider when trying to regulate the new generation of urban transport and develop a travel facilitating smartphone app.

4.3 Empirical willingness-to-change thresholds

Both external and internal barriers have been found empirically to influence travel behaviour. Personal budget in terms of money, travel time and convenience is dominant, but internal barriers such as individual attitudes and subjective perception are also significant (Transport Analysis, 2011b, and Seethaler and Rose, 2003). Men, women and different age groups furthermore have different needs, as suggested in section 4.1. Sociologist Åsa Waldo (1999) at Lund University has conducted in-depth interviews with travellers in Malmö, Sweden, to review their daily travel patterns and identify needs of specific groups. When urban planners speak of ways to reduce car traffic, Waldo means that they make unsatisfactory considerations to *why* people choose the car. Dell'Olio, Ibeas and Cecin (2011) have conducted a similar study, based on interviews in Santander, Spain, of what users and potential users of public transport expect and want from the services. Both studies are referred to below. A number of other factors influencing travel behaviour have been found in statistics and other literature – in this thesis also assumed as indicators of specific needs relevant for the planned ICT solutions (Figure 5). The success of the SUNSET and ISET sustainability objectives is potentially highly dependent on how well they meet these needs – both in terms of dealing with external barriers and influencing internal barriers.

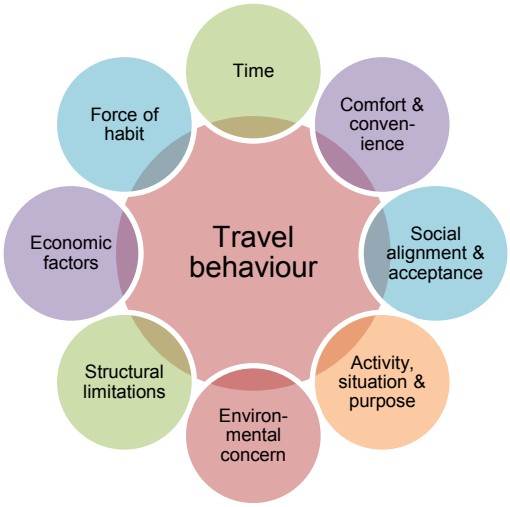


Figure 3 Internal and external barriers influencing travel behaviour

4.3.1 Time

Travel time versus waiting time

Time is the most valued barrier when choosing means of transport (e.g. Eliasson, 2001, dell'Olio et al., 2011 and Waldo, 2002). Travel time is however shown to be more accepted than waiting time (e.g. Stangeby and Norheim 1995 and Eliasson 2001). In Eliasson's material (2001), motorists mention time-consuming congestion as a reason for choosing the car, and public transport travellers mention the same reason for taking the bus or train. Here is an obvious matter of subjective understanding and valuation of crowding and congestion – some consider a crowded bus worse than waiting in traffic jam. Wardman & Ibáñez (2011) states, through surveys of motorists in the US and the UK, that the value of motorist's waiting time varies with the traffic situation – not only between free flow and congestion, but divided into a finer scale of holdup. The authors attach different multiplier values to different types of time, in order to give planners a guideline of motorist acceptance and time valuation. They suggest e.g. a value multiplier of 1,15 for busy traffic and 1,80 for complete gridlock (Wardman and Ibáñez, 2011). Time evaluation is especially interesting in urban planning as car congestion is increasing in many European cities (The Economist Intelligence Unit, 2010).

Waiting time is a cost function within travel that has to be minimized. Stangeby & Norheim's study for Transportökonomisk Institutt (1995) showed that the maximum accepted waiting time between departures, if to get motorists to choose public transport, is 15 minutes. Interviews with households in Gothenburg on their attitudes and values of the car, has shown that this figure is 10 minutes (Andréasson, 1993). Today, it is likely even lower, as our urban society has become faster and faster. Emeli Adell (2011) at the Swedish traffic system developer

Trivector, means that solutions with minimum relative difference between the alternatives will work best, e.g. if the bus takes about the same time as the car, the bus is likely to be the choice, she argues. This is also indicated by Waldo (2002).

Information and planning

When taking the car, you need not plan much ahead where or when to go – an obvious benefit found by Waldo (2002). Safety to know that the bus or train arrives on time is also important in Eliasson's (2001) material, and that the travel time will be as expected and possible disturbance reported to the traveller. Information is considered better in metro or tram than with busses, which by many respondents is considered a clutter. In Flash EB (2007), car users stated that a better schedule (especially stated by young and urban citizens) and better connections (especially stated by employees and urban citizens) would be most likely to attract them to use public transport. 22 % said that no changes to the public transit system would make them change their attitudes (Figure 6).

Waldo (2002) also finds preferences stating that the car enables precise arrival – not too early or too late. Public transport schedules are seen as difficult to optimize in matter of arrival time, and perhaps you have another time to catch. This strong belief in the car trip as quick, short and flexible seems somewhat distorted in urban reality, if you consider increasing congestion and the effort and time spent on finding somewhere to park the car. In addition, people seem to forget walking to and from the parking lot, while walking to the bus stop is more clearly visualized (Adell, 2011). Again, this seems to linger with travellers as a psychological, internal barrier.

4.3.2 Comfort and convenience

Dell'Olio et al. (2011) have found that waiting time, cleanliness and comfort stand out as external quality indicators, although with varying degree between different groups. Comfort and convenience are factors identified also in other literature (e.g. Eliasson, 2001). The public opinion is often that alternative travel is good, but that its performance and comfort is inferior to the car (Swedish Transport Administration, 2006). In his report for VINNOVA (2001), Eliasson mentions access to comfortable seating, standard of the vehicle, temperature in the vehicle and the maintenance of stops and stations. Available seating is listed highest in willingness-to-pay for comfort (85 SEK/month). Comfort of entertainment, reading, and other activities, are interesting in regards to the high usage of smartphones. Many smartphone func-

tions are ruled out when driving a car. It is difficult, not to say dangerous, to read email, surf the Internet or log on to Facebook whilst driving.

The aspect of safety can be elaborated. Urban traffic corresponds to near 70 % of road accidents, and car drivers and passengers of cars together account for 50 % of all European road accident fatalities (European Commission, 2011a and b, and DaCota, 2010). The other major groups are motorcycles and pedestrians, but bus and train passengers are too few to even be explicitly represented in the statistics.

4.3.3 The force of habit

Travel patterns are hard to influence since new modes of transportation intrude and affect the disposition of time and routines in everyday activities; both travel route and errands that are usually combined into the everyday trips (e.g. Carlsson-Kanyama and Lindén, 1999b and Waldo 2002). People are foremost habitual in their travel behaviour and the chosen travel modes are a part of their lifestyle, or comfort zone. Change is thus laden by a substantial inertia and risks to take a long time to accomplish. Travel changes are mostly made if or when something new occurs in people's lives, e.g. a new job or the birth of a child – phases which often create uncertainty and where help is appreciated (e.g. Waldo, 2011 and Kramers, 2011).

4.3.4 Activity, situation and purpose

Different modes of transport are the routine choice depending on the nature of the trip. Waldo (2002) finds in her interviews that the car is more frequently used for planned, shorter errands, while public transport is accepted for not-time bound activities. Households often experience that they do not have a choice; they have to take the car e.g. for weekly grocery shopping for a large family (Waldo, 2002). From a sustainability point of view, according to a study at Karlstad University (Williams and Wikström, 2011), these weekly grocery shoppers throw away more food than do those shopping less frequently. Possibly can joint interests be found here, between sustainable food handling and sustainable transport?

Many professionals travel in work, and mobility is sometimes a part of the very business model, e.g. for consultants and craftsmen. Many use company cars also in private life. This makes other modes of transport difficult to introduce and subject to employer/company policies and engagement. An interesting publication on commuting habits and transport choices is Transport Analysis' report 2011:3 from 2011.

4.3.5 Economic factors

Travel cost is an obvious external barrier in the choice of transport, especially for public transport travellers (e.g. Eliasson, 2001, Transport Analysis, 2011b and Flash EB, 2007). A season card is not considered as expensive as paying cash or with coupons (Eliasson, 2001). Bus and train might be seen as more expensive than the car due to the tagged nature of car costs – fuel, insurance, devaluation, and maintenance. All show in separate ways, difficult for people to overlook and distorts the comparison with public transport prices. A high cost might be accepted if the quality of the choice is superior in importance for the individual, such as travelling by car (Waldo, 2002).

Transport Analysis (2011b) means that the choice of transport also is guided by economic incentives such as deductions for travel expenses, fringe benefit tax, subsidised work place parking and congestion charges. In Sweden, congestion-, and road charges are deductible, which creates a dilemma if to reduce car travel. Possibilities to get subsidised public transport cards and tickets at e.g. the workplace are other relevant economic incentives. 54 % of Europeans are meanwhile willing to pay extra for less polluting means of transport, although generally not more than a 10 % increase (Flash EB, 2007). Men are less inclined to pay extra than women, as are older and less educated. However, the 9 % willing to pay over 10 % extra were most likely to be men, young and highly educated.

In Flash EB (2007), Europeans think the best strategy to encourage sustainable travel and bio fuel use in particular, is to make it cheaper through tax incentives. Waldo (2002) finds however that cost changes has little effect on travel behaviour, and that economic policy instruments, such as petrol taxes, have to be substantial for any influence on travel habits to occur. Interviewees generally answered that they would pay a potentially higher cost for taking the car, and cut down on something else. A willingness-to-accept study would be interesting here, what level of reward or grant would make travellers chose public transport.

4.3.6 Structural limitations – urban form

How the transport system is designed influences how it is used; with what modes, how often and how far we travel. It is challenging for city planners to extend the number of routes and timetables in the set urban complex, and it is further complicated by the European trends of urban sprawl and the built-in car dependence in cities. Still, 90 % of Europeans think that their local traffic situation should be improved (Flash EB, 2007). About 49 % of these think that better public transport would be the best way to do it.

Transport Analysis (2011b) mentions structural limitations for urban public transport in larger cities in Sweden: e.g. lack of bus lanes, lack of capacity in the rail network and lack of vehicles, poor winter readiness and inadequate traffic information systems. Location of the household and work place relative the public transport network is also an obvious parameter to traveller's willingness to change. 12 % of car users in the EU (especially women and students) think the stop needs to be closer to their home (Figure 6, Flash EB, 2007). Waldo concludes that policies and urban planning have to create conditions where people are given a chance to change their behaviour in a sustainable direction i.e. leave the car (Waldo, 1999).

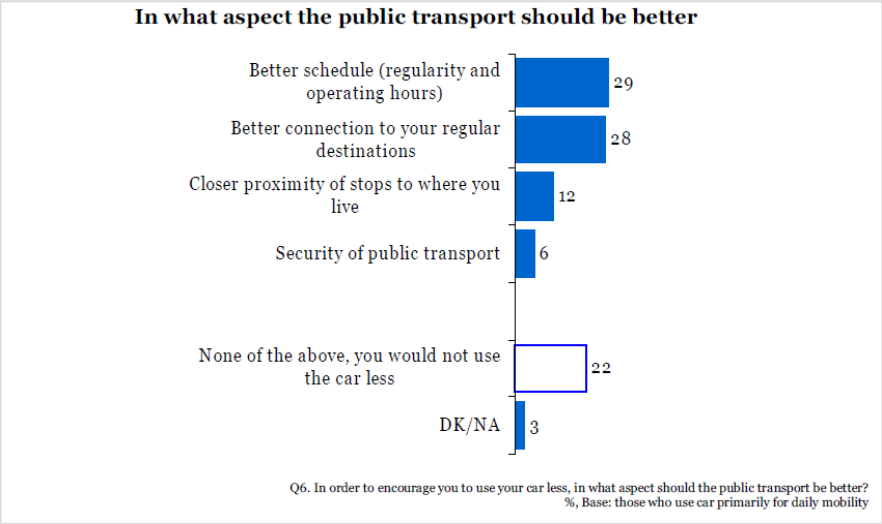


Figure 4 Preference of improvements of public transport (Flash EB, 2007)

4.3.7 Environmental concern

Today the medial and political discussion of environmental concern is intense, as well as the social incentives to act by environmental consideration. Nonetheless, passenger car travel is, as shown, not decreasing. Individuals that in other aspects try to act environmentally conscious usually have the same car-based travel patterns as others (Ljungberg, 2003).

People have always understood the significance of nature and the environment differently, depending on knowledge and experience. With continued urbanization and industrialization however, the generations who have experienced a life more closely dependent on nature are disappearing and the general degree of environmental knowledge and concern is decreasing. Many Swedes still consider themselves environmentally conscious; especially women (Transport Analysis, 2011b). Within the EU, eight out of ten consider the car and how it is used to pose a considerable impact on the local environment (especially women, young and highly educated), and 26 % switch to public transport as a strategy to reduce emissions (espe-

cially young and urban citizens) (Flash EB, 2007). An American study by Kahn and Morris (2009) has further found statistical significance between community environmentalism and the tendency to travel sustainably. The reviewed literature finds few other connections however, between knowledge about and concern for the environment and travel behaviour. Seethaler and Rose (2003) go through a number of studies indicating the absence of such correlation, and thus recommend planners to preferably work with participatory engagement rather than pro-environment information.

4.3.8 Social alignment and acceptance

With urbanization, the mixing of cultures and people gradually alters identification mechanisms (Lindén, 1994). Choice of transport mode can constitute such a mechanism and add value to the traveller in the sense of status. The car has a symbolic consumption value for many in the choice of brand, model, interior etc., which complicates the encouragement of public transport. Economy professor John List has studied consumption and non-market mechanisms, and found that people suddenly value goods higher when they own them, although experience and knowledge eased this reasoning somewhat (Harford, 2008). There are plenty of recent indicators or trends of non-market mechanisms, such as studied by List. Johan Wirfält (2011), editor-in-chief of Rodeo and Swedish free-lance journalist, discusses the rise of counter-reactions to the 00-century consumption lifestyle, such as second hand shopping, couch surfing and carpools. Internet has paved the way for this *collaborative consumption*, a concept coined by Rachel Botsman and Roo Rogers in their book *What's Mine Is Yours* (2011), and second hand markets as Amazon, Ebay and Craigslist on the top-ten largest American sites (Collaborative Consumption Hub, 2011). Through social media and new ICT vehicles, learning from others and getting response on your behaviour is much easier than before, and this networking becomes an important aspect in the rising of new behavioural trends such as collaborative consumption.

Arriving by car rather than by bus might moreover sometimes be more socially accepted, e.g. for a company CEO. The professional affiliation and associated identity expectations might, according to Lindén (2011), be more important for travel patterns than the personal proximity, although neighbourhood social norms have some impact on travel behaviour. E.g. households in suburban areas are expected to own at least one car.

The bus is seen as low-status transport in many regions, mostly used by women, young and old (Flash EB, 2007). Trains and tram traffic is generally more accepted. The so called *rail*

bonus – to what extent the number of travellers increases when changing the public transport from bus to rail – is by experience approximately 25 % (Kasch and Vogts, 2002 in Johansson, 2011). The suggested explanation by Spårvagnstäderna (2011) is a larger appeal in rail transport compared to road. The status of bus traffic might be possible to improve through structural planning such as free Wi-Fi on the bus, modernizing the fleet etc. In Stockholm, Sweden, the public transport has been modernized during 2011 through e.g. rebuilding of terminals and waiting areas (Storstockholms Lokaltrafik (SL), 2011). The European Passenger Week is another cross-border example of ways to increase awareness and acceptability of public transport (Swedish EPA, 2011a).

A final aspect suggested in Waldo's empirical study (1999) is the division of individualism and collectivism in the choice of transport. While driving, you have control and power, a sense of security as described in 4.2. On the bus or tram, you are a part of the masses, without influence or control, leaving many feeling unease, which might well be a reason to prefer the car. These factors are emphasized further in the event of Europe becoming more and more individualistic (Elliott and Lemert, 2009).

5. Transport facilitating smartphone apps – ICT as a policy tool

Way over 90 % of Europeans use a mobile phone today, and the usage is high in most age groups making mobile-based information a powerful tool (Table 5, appendix 3, Eurostat, 2011c). The present market share of smartphones is difficult to determine, but IT analyser Gartner, Inc. (2011) indicates a figure of 25 % of global mobile phone sales, and a 74 % increase in the second quarter of 2011 alone. The mobile market analyser Avdmedia makes an educated guess of 1, 8 million smartphones in Sweden alone (Avdmedia, 2011).

Contextual apps are, as Bellman, Potter, Treleaven-Hassard, Robinson and Varan (2011) suggests revolutionary technical innovations providing maybe the most powerful way of advertising yet developed. Swedish Public Transport (2011) has established that the goals of sustainable mobility only can be met if public transport is made easy to understand, relevant and perceived as simple to use. In order to be relevant for the traveller, they obviously also have to be easily accessible and suit the individual's travel pattern in terms of geographical proximity, frequency of fares etc. ICT and smartphone apps bring these needs and conditions closer together by providing the required information, and help the traveller to access a more sustainable travel mode.

5.1 Do apps influence our behaviour?

Generally, the closer the information is to the recipient; the more likely he or she is to take interest (Lindén, 2011). This gives mobile technology further advantages, since the mobile phone is assumed to be kept close at most times, in a pocket or purse, and of some even seen as an extension of the body (Bellman et al., 2011). The mobile phone is accepted as a platform for highly personal information and entertainment and users have a strong emotional attachment to it. Bellman et al. (2011) have studied the effectiveness of branded mobile phone apps, and finds that they have a persuasive impact on shifting purchase intention, especially those with an informational/ user-centred style. Their explanation is that: *this* [app] *style focuses attention to the user, and therefore encourages making personal connections with the brand* (Bellman et al. 2011, p. 191). They also argue the importance of *relevance*, although they do not find statistical support for it. It would be difficult to convince people to download an app they do not consider relevant. Finally, they find that smartphone apps even have the potential to increase interest in a whole product category. The public transport system is assumed to equal such product category.

Many infrastructural companies and organizations have seen these advantages of apps and begun a race into the marketplace by launching a range of travel app solutions (Table 2, section 5.4). The ones reviewed in this study are foremost travel planners, CO_2-calculators and GPS solutions. However, only Bellman et al.'s (2011) study have been found on how and to what extent this new technology effect our behaviour. Other literature also express a lack of research (e.g. Shankar and Balasubramanian 2009, Bellman et al. 2011 and Calder, Malthouse and Schaedel, 2009), but the field is likely to expand rapidly. No studies have been found on the potential for mobile apps to influence, or help, users to make sustainably sounder decisions in their daily life. Anna Kramers (2011), PhD student at KTH Royal Institute of Technology, Sweden, is currently conducting a similar study as this one, which might be interesting for further understanding of the use of app technology in sustainable travel. As with other high-tech applications, the development of smartphones and their software is likely to continue at a high speed and its optimal usefulness is still to be seen.

5.2 Compilation of general traveller preferences – apps

Despite this lack of research, a number of conventional *do's and don'ts* have been identified that make mobile information theoretically effective in influencing consumer behaviour. For example, Shankar and Balasubramanian (2009) discuss aspects relevant for text message mobile advertisement. Apps are more of a pull- than push tool as described earlier, since the user him-/herself chooses what apps to download, but the aspects are still assumed to be generally relevant. Other aspects found are also included below.

- *Fulfil a need:* first of all, the app has to satisfy a need. According to e.g. the economic theories of man, we seek to satisfy our needs through our actions, which is also detectable in what information we take in. Apps almost always facilitate the daily life of the user in some way; simplifying, solving problems, assisting, or entertaining. Be it weather forecasts or an entertaining game.

  The need should not be already satisfied by an existing solution, at least not completely. The idea should use and develop the mobile experience – distinguishing the solution from desktop computer possibilities (Wooldridge and Schneider, 2010). A transport facilitating app at least needs to contain a travel planner with information of a number of alternatives, the nearest way from A to B, but also the time to get there by car, bus, tram, bike, or walk respectively. Furthermore, comprehensive maps with directions should be available. Adell (2011) stresses the importance of providing the user with real-time updates, such as

delays. Arnestrand (2011) on the other hand, means that real-time might foremost be relevant for problem-prone routes. That the regular traveller not considers this, and that delays are a failure of the product itself – the trip.

In terms of convenience, there is the question of user patience, what margin of error is accepted in the app functions. No technology is faultless. Regarding real-time updates for example, sudden traffic situations or communication problems in the systems might influence the performance – how patient are the users in this sense? What can be done not to cause irritation or aversion? If better precision is secured on the expense of mobile battery power, is that accepted?

- *Get the users to opt-in*: an early consideration is how to get the users to download the app. Naturally, the app needs competent advertising and distribution to reach out, see section 6.3.1, but the content also needs to be relevant for the user, offering significant benefits or additional values, as discussed in section 4.2 (Shankar and Balasubramanian 2009, and Blum and McClellan 2006). E.g. to boost public transport in Korea, Quick Respons (QR) codes of groceries where available in the underground platforms, and the foods that you scanned was sent to you in the evening (Adell, 2011). This solution made better use of people's waiting time and offered the added value of saving extra trips for grocery shopping. Another solution is to have the service/app enclosed in the product or subscription from the beginning, for example as the cooperation between Swedish telecom company Telia and Spotify (Telia, 2011). This would be possible through business collaboration between the app developer and the smartphone manufacturer, and would potentially bridge the problem of getting the user to download the app. On the other hand, the user might be less excited and inclined to explore the app if it is included in the phone; compared to apps they download themselves.
- *Easy to understand:* many impressions seek our attention, and little time and effort is generally given each media vehicle. Attaining interest and getting the message through therefore requires a simple and understandable interface with a clear message. The app should not be showered with information or functions, but rather offer optional add-on's based on individual needs. A project at SL in Stockholm added a CO_2-emission calculator in the existing public transport planner app. User surveys soon showed, however, that the new information was of no importance to the users – no one stated that it would change their behaviour. Besides, the users of the app had already chosen the more sustainable alternative so convincing them further was to no use (Arnestrand, 2011).

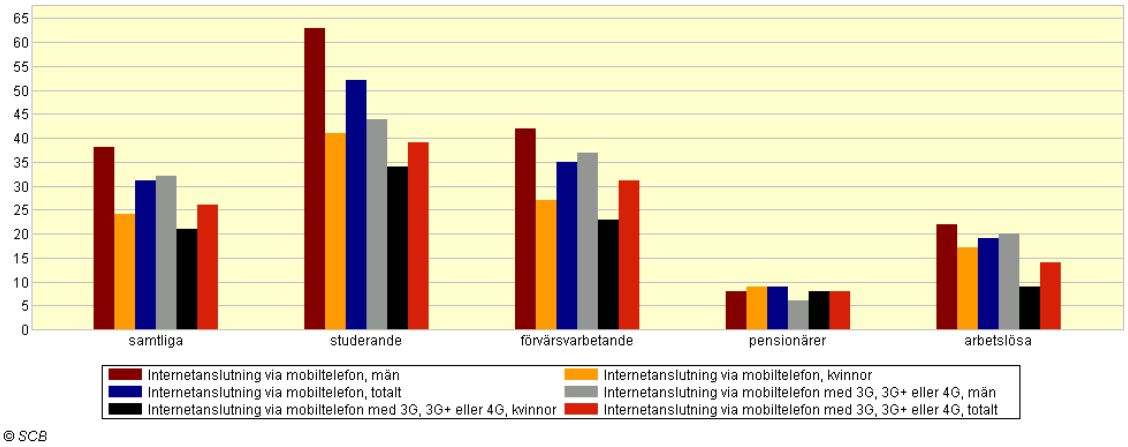
A simple interface furthermore enables quick upload and start of the app, which Adell (2011) states as an important aspect, after comparisons between existing services. Furthermore, it has been found favourable to avoid too much manual writing, e.g. when locating an address.

- *Social networking:* Today, many interact foremost through the use of mobile phones or web based social media. These two networking tools are joined in smartphones and the ability to contact others, display preferences, lifestyle and share experiences with family and friends are recognized and appreciated (Shankar and Balasubramanian, 2009). An Australian study from 2008 shows that mobile phones enhance feelings of belonging amongst youth, and that creation of social identity is connected to mobile phone use (Walsh, White and McD. Young, 2008). Within non-physical social media, such as Facebook, applications are assumed to create their own social status levels and be a way for individuals to benchmark and define their identities. Users shape their outward image and personality by which pages they "like", groups they join and apps they download. The Australian study is narrow and few similar have been conducted, but the result is assumed to be a suitable indicator for the social impact of mobile phones, and apps secondarily.

  As mentioned in section 4.3.8, networking can be effective in behavioural change, due to response mechanisms and learning from others. Studies of Intelligent Transportation Systems (ITS) has shown that a connection to Facebook is the most successful model for this kind of information technology, e.g. for carpooling with friends (Adell, 2011). The importance of ICT and networking has also been shown in the rise of Rogers' and Batsman's *collaborative consumption* trend. Apparently, these new opportunities have the power to create large-scale behavioural changes.

Access to mobile Internet is a relevant factor for the SUNSET/ISET objectives. Table 1 shows the access in Sweden in 2011, where male students are the dominating group, and senior citizens have the least access (SCB, 2011). Five years ago, in RES 2005-2006, 23 % of the total had access to mobile Internet (SIKA, 2007). Today that figure is 31 %, a considerable increase (SCB, 2011). In the EU, the total figure is 8 %, but as high as 16 % for young men (Table 6, appendix 3, Eurostat, 2011d).

Table 1 Access to mobile Internet in Sweden in ages 16-74 years (%) for 2011 by type of access, sex and demographic division. All, students, workers, senior citizens and unemployed. Source: www.scb.se



5.3 Consignor

Consignor credibility is important for how information is received, in this case by the app user. The general conclusion in advertising literature is that if consumers are highly engaged with the media vehicle they can be more responsive to the information (e.g. Bronner and Neijens, 2006 and Wang, 2006 in Calder et al. 2009). Depending on which information is communicated, different levels of criticism are raised and different levels of credibility are required. To attract motorists to change travel behaviour, credibility is likely to be essential. Perhaps what is said in media, by others or by friends is most credible for travellers. Perhaps the engagement is strongest with social media, as suggested by Adell (2011), with little interference by official authorities. In some regions or groups engagement may be strong with governmental agencies such as the Environmental Protection Agency. The optimal consignor of the SUNSET/ISET message is difficult to determine, and perhaps no explicit consignor at all is the best alternative. Such solution would avoid the inevitable value-laden impact of any consignor. The decision is a cultural and social balancing act, opening for market surveys and empirical data on what is perceived as credible.

Distributing the SUNSET sustainable travel app through the municipality might be beneficial. The non-profit nature of state channels ensures long-term achievement and opens for collaboration between urban planners, infrastructure, public campaigns and sustainability policies. The state's mission is to serve its citizens rather than seeking profit. Lindén and Carlsson-Kanyama (1998) means that such combination of policy instruments have the highest probability to bring on behavioural change.

Wide-spread use of travel apps might also give the consignor or developer access to detailed data of individual's travel patterns, as well as feedback and interaction. Actual travel habits

can be used by urban planners to tailor flexible solutions, beneficial also for travellers and inhabitants. Future transport systems can be based on needs rather than authority planning. Better planning also means better cost effectiveness and use of resources. If the app is distributed through the smartphone manufacturer, as mentioned in 5.1, the reception is improved even further. Instead of only attaining information of the ones downloading the app, even travel pattern of people with a smartphone (of that brand) will be detected.

5.4 Existing solutions

Table 2 Selection of available transport-related solutions on the Swedish market, December 2011. Identified through recommendations from branch professionals.

Application	Description	Rating (max 5)	Downloads	Consignor
Skånetrafiken travel planner	A real-time travel planner. The user have to write the address for each search and the app takes a while to start/work.	3.2 (665)	50 – 100 000	Skånetrafiken
Lokaltrafik Skåne	An app showing timetables for buses and trains in Skåne. Not in real-time but with GPS. Possible to save favourites.	4.5 (363)	10 – 50 000	Private (Johan Gunnarsson)
Många Sträckor Små	An app where users upload bike trips and take part in competitions, top charts, statistics and other incentives, making taking the bike more profitable and fun.	3.3 (21) Android market	1 – 5 000	Lantmännen
Resrobot.se	ResRobot is said to be a unique travel planning service for travel and travel combinations for all types of transport modes all over Sweden. It is available as a website, app and mobile website. Real-time for some regions but not all.	4.4 (344) Android market	10 – 50 000	Samtrafiken in Sweden
Commute Greener!	An international travel app aimed to help users understand how to commute greener, by calculation environmental impact. It is also a social interaction tool , where you can locate other users and travel together, make competitions etc.	-	-	Volvo IT
SpaceTime	Web service for organizations and companies to support carpooling and note CO_2 emissions.	-	-	SpaceTime Communication AB
GreenBits, winner of TravelHack 2011, Trafiklab	Encourages climate friendly travel by inviting the user to challenge themselves, friends or celebrity in everyday travel. Points are rewarded with discounts, better health and better environment.	-	-	GREEN bITs (not yet published)
Reseplaneraren	Travel planner, gps, real-time for some fares, indicator telling you if you are close enough to the stop to be on time, maps.	3.7 (347) Android market	50 – 100 000	Västtrafik
Västtrafik JustinTime	Real-time information to avoid waiting and stress. The same info as on bus stop displays.	4.1 (40)	5 – 10 000	Västtrafik

6. Discussion

6.1 Mobility Management

Technical development will not alone ease the environmental impact of urban travel, and neither will the slowly staggering increase in public transport. Reduction and prevention of emissions is the only way to de facto reach environmental and climatic relief. It is wise to have infrastructural policy ruled by the four stage principle and the ambitious EU white paper on transport, where demand-related measures are promoted. However; to what extent are these policy frameworks really implemented? Eco car grants and local investments in large-scale suburban shopping complexes and roads rather seem to listen to the call of capitalism and the neoclassic focus on limitless economic growth, and favour a continued increase in car travel. Is as much money given to non-car based infrastructure? If the objective is sustainable development, new and efficient tools and re-designed policy paradigms in both economy and urban lifestyles are needed – ambitions that only have a chance of succeeding if political and strategic management measures not contradict one another.

6.1.1 Collaboration

Collaboration is needed – over borders, within administrations and organisations, but also between the corporate world and the state. Objectives to reduce urban car travel will not go well with merchants and sellers. They want people to visit their suburban shopping malls and spend money, and to fill up their vast parking lots. This is also an interest of local authorities, since it creates employment and growth in the area. Obviously, sustainable travel objectives have to go hand in hand with other social objectives in all political levels. The EU or national parliaments have to give incentives to companies that favour increased use of e.g. public transport, much like the sales incentives for eco cars. One can consider that a public transport receipt in the mobile phone is translated into a sales offer, such as 10 % discount, and that the merchant is given some sort of relief from the state. The relief might e.g. be a tax reduction as has recently been done in Sweden with restaurant VAT. This would foremost be a method of listening to multiple interests, although some travellers might be attracted by external discounts. The space taken by parking lots, assumed to cost a great deal of money, can further be developed to create attractive cities for the growing population as green areas, housing or commerce. The trick is to reduce car travel without diminishing mobility, and to make everyone happy.

If politicians decide they want more people to use public transport, the public transit capacity and performance has to be increased and assisted – and the incentives for doing it are strong. Urban Europeans request better connections if to choose public transport (4.3.1), an improved local traffic situation and stops closer to home (4.3.6). Providing schedules, maps, and real-time updates in apps will be in vain if the performance of the transit mode is failing. If the bus is always late or full, or if come winter the train never arrives, people will not care about any travel app and return to a car-based travel. The same is assumed to be true of the standard of stations, bus-stops and platforms – if they do not protect the travellers from weather, provide the best possible comfort and keep each traveller safe – all measures no matter under who's authority will be a failure.

If to promote a workplace on the train or bus and the competitive weapon of efficient time, especially since professionals are such an important urban travel group and with large potential of environmental benefits, there have to be an available seat for each traveller and receptacles for charging laptops or smartphones. Free Wi-Fi is also important, no matter if many users have a subscription with access to mobile internet. If parents are to trust the transport system taking their children to school, the school bus network has to be improved. Collaboration between urban planning, the interest of transporting companies and sustainable travel is therefore initially crucial. Considering what is found about rail bonus in section 4.3.8, investments in rail transit is especially interesting. Extended bus lines are however still needed.

6.1.2 Policy

Do we see a new era of information technology that will revolutionize our daily lives to the extent that mobility patterns are altered and national and international sustainability objectives facilitated? It is not yet possible to foresee for certain, but maybe this wave of innovation will at least facilitate urban planning or even make it less relevant in the aspect of changing travel behaviour, discussed in section 5.2. Through detailed information of the app users through GPS and tracking devices in the smartphone, provided much like personalized advertising through social media, urban planners potentially have access to a cost-effective blueprint of individuals rational behaviour and what changes are needed and where.

The policies behind the SUNSET project need to be based on the rationality of travellers, and that also habitual behaviour is rational. You do as you always have done since you then act within your comfort zone and minimize the risk of mistakes. It is not to forget, however, that the ruling economic theories about rationality that shape modern society and naturally influ-

ence how people act, reflect the times and societies in which the theories originate. Many theories were born in the late 19th century – a time without widespread globalisation, without limited resources, global climate change issues, cars, ground-breaking IT solutions, and without smartphone technology. For sustainable development within the passenger transport sector, it is important to seek to widen the view of the consumers/travellers from purely Economic Men, and be sensitive to other theories about individual objectives and budgets. Alternative economic theories, such as institutional economics, are gaining momentum, since it is noticed that the resources are becoming scarce, that people have a limited time and number of alternatives rather than infinite, and that consumers are intensely affected by highly intellectual marketing. One should also be aware that new perspectives inexorably are hard to implement and that prevailing structures and incentives are complex and several powerful actors enjoy their fruits, perhaps the reason why present laws and structures often favour passenger car travel.

Reasons why the car is considered cheap and fast compared to alternative modes can in many cases be that external costs are not included in any of the costs and the tagged nature of car expenses. The policy aim to include external costs in transport is therefore relevant for the MM and sustainability objectives of the SUNSET and ISET projects, as are regulations of deductions for travel expenses, congestion-, and road charges. These and similar principles distort the objectives of sustainable mobility.

6.1.3 Surveys

No matter how well the app is prepared and marketed, no one will download an app that is not in their interest or is the innovative talk of the town attractive of pure curiosity. Different groups are interested in different solutions, and I recommend developers in the SUNSET and ISET projects to carefully base the development process on empirical surveys, even though the element of innovation is strong and perhaps what will ultimately attract users. Even innovation needs to be grounded on a certain amount of knowledge of what people are interested in. The seemingly most cost-effective way to find out what people need, apart from the potential use of the above mentioned smartphone tracking functions, is to ask them. Considering that not much has happened through present policy measurements to influence mobility patterns, innovation and a degree of risk taking might just be successful.

The following empirics would be interesting to analyse: **a)** Travellers' willingness-to-pay for virtual solutions assisting them in an everyday travel context, what they would like to see in-

cluded in the app, most preferred "carrots" and what would give a gilt edge to their travel. **b)** The typical everyday errands and combined trips for the urban households, in order to optimize the app according to these patterns (4.1.2). **c)** What is considered attractive with travelling in a car? This is interesting in order to counter the behaviour actively (4.2). **d)** Perception of consignor credibility – who do we trust and who's opinion weigh the most? (5.3) **e)** Considering that people have been found to rather pay the increased cost of fuel/tax than abandoning the car, a willingness-to-accept study on a grant system would be interesting. What level of reward or grant would make travellers chose public transport (4.3.5). **f)** Finally, users' accepted margin of error in the app function (5.2).

6.2 The traveller

Urban Europeans are dependent on transportation, but the problem facing sustainability objectives is how they relate to this need and how they choose to satisfy it. Travellers least likely to give up their car are habitual middle-aged working men, with a good education, a decent income and most likely a smartphone. The facts that men have a larger access to driver's licences and a car than women, the short distances covered and the fixed travel pattern further emphasises the improvement potential in men's travel behaviour.

The ones most likely to alter their behaviour by using a smartphone app are assumingly younger people and students, due to their unfixed personal orientation and general openness to change. Older people will potentially become a more distinct travel group in all transport modes in the future, and their increasing usage and familiarity with ICT tools can make them a future target group for specific app solutions. As it is now, older generations are more or less dependent on public transport and do not travel much at all (4.1.2). The fact that this group is growing, further indicates the urge to boost and improve public transport. Besides, rooting a sustainable behaviour already before this group reaches a high age seems the most sensible. This ought to be true also for today's young. Since travel behaviour is founded in an early age (4.1.2), enticing children to use public transport is a way to induce more sustainable future travel patterns. In a long-term perspective, this would be a way to avoid the potential boom of future car traffic in Europe.

6.2.1 Costs and benefits

The modern individual needs to be everywhere at the same time. Stress is a buzz-word and time is quite right found to be the most explicit barrier for travel behaviour. On the other hand, the fact that the Swedish urban travel is shortest but takes the longest time, and that the

car still tops the city modal split, indicates that time not always is accurately determined when weighing costs and benefits. The real issue for sustainability objectives in urban transport rather seems to be psychological – the car is of habit considered to be time saving. Perhaps convenience and being able to make errands and combined trips is most important after all, especially for households where the travel affects more than one family member, or we value social acceptance higher than we think. The monetary cost is also assumed to be a distorted costs/benefits-factor, considering the details in section 4.3.5. Mainly public transport users ponder high travel costs, not car drivers, and a majority of Europeans are willing to pay extra for less polluting means of transport. Besides, despite rising fuel prices and tough economic times, car travel and car sales are increasing.

Whatever the reason, the aim of the SUNSET and ISET projects is to foremost reduce car travel. Focusing on the most frequent and undeniably habitual travellers is therefore sensible.

6.2.2 Cognitive dissonance and psychological perceptions

As the empirics indicate in section 4.3.7, many car drivers are aware of impacts from road transport and might also be concerned about environmental issues in general. The primary driver group is besides generally highly educated. Still many see no alternative to the car or are not interested in considering alternative solutions. This is confirmed by the observable lack of correlation between environmental consciousness and travel patterns, and classical behavioural theories of the difficulty of acting actively to ease global issues (4.2). Travel rationality does obviously not derive from awareness in this group. Planners and consignors of sustainable travel solutions have to be aware of the difficulties of foreseeing this cognitive dissonance, and try to identify other costs and benefits creating motivation to act. The difference that occurs between subjective ideal and realization in travel patterns has been shown to derive from e.g. structural obstacles of too few bus lines, economical obstacles of expensive tickets and time concerns. The 22 % not willing to change for any alterations of the public transit might e.g. be more likely to reconsider if the incentives focus on the aspect of time-saving rather than pollution reduction or green values, since time is a more accepted cost factor.

The successful public transport trial periods, e.g. by Västtrafik, and the cognitive theories of practically vested knowledge and learning by doing, indicate that it is more efficient to have people actually perform the wanted behaviour than simply providing information of the benefits of sustainable travel (4.2). Perhaps riding on the wave of smartphone technology and apps

is a way to make people try public transport, since the identified target groups are the ones with the largest mobile phone use. Mobile phone use should, however, not be a factor given too much consideration – the usage is bound to increase to near 100 % in all age groups with time. Also use of mobile internet is on a steady increase as shown in 5.2, with a 12 percentage point increase in Sweden in five years.

6.3 Transport facilitating smartphone apps

The SUNSET and ISET sustainability objectives both go well with the first two steps in the Swedish Transport Administration's strategic four stage principle, as well as with the tone in the EU White Paper on transport (2011). Considering the documented effectiveness of other demand-oriented instruments, a high-performing and well distributed app facilitating mobility might be a part of the solution to create a substantial switch to public transport travel. The foremost potential is not in the technology as such however, but in how they are used and accepted of users as information and communication channels.

6.3.1 Attracting users

To catch the interest of rational drivers and have them download the app, I suggest using the very channels which the app is coupled to e.g. social media, and spread the word through sharing with friends on Facebook for example. The benefits of this are also shown in section 5.1. If the GPS-function of the mobile phone is added, one can locate friends in the area that might be interested in travelling together etc. This way the message is attained through the personal comfort zone and possibly valued differently. Giving a flyer or other information about the SUNSET/ISET project and the app when buying e.g. a bus/metro card might also be efficient. Even though it would address travellers already in a more sustainable travel pattern, it might encourage it further and also be passed on to friends. Other solutions are to link through relevant websites, e.g. the transporter, the municipality etc., or to initially target usage of functions foremost aimed at rationalizing driving – e.g. the parking assistant (6.3.2). This add-on can be distributed alone and entice the user with further updates and functions that will help the user in his/her travel routines.

From another perspective, the SUNSET/ISET objectives can translate into a business model rather than purely technical applications. Bundling services and objectives is usual e.g. with plastic cards, connecting to else – bonuses, benefits, discounts etc. – that have nothing to do with the core business to fortify the objectives. For example, if you use a certain credit card, the app is provided to you for free. This is a way of finding the self-selling aspect of the ser-

vice, and enticing a constant stream of users. Collaboration with companies is an interesting solution also in the sense of selling the idea to workplaces. The SUNSET/ISET objectives can coincide with business corporate social responsibility objectives and good will. It can also be a way of entertaining the employees, inviting to challenges etc. (6.3.4).

6.3.2 High technical performance

To make the SUNSET objectives successful, the app has to create customer benefits as any other product or service. Solutions where the user gets obvious and comparable, or perceived, benefits of time saved, efforts lessened and/or money spared.

The app needs to provide at least the existing solutions of public transit schedules, maps, subway maps and *real-time updates*, and making it simple. Perhaps even an oral GPS-guidance to listen to through headphones. Cluttered and complicated schedules are still an explicit reason to avoid public transport, and the easier the solution is; the higher is the motivation to act (4.2 and 4.3.1). I consider real-time to be important, especially for workers and students. This preference is also found empirically. The need for real-time updates depends on geographical location and occupancy, but the importance of precision should never be denounced. The app will thereby facilitate and shorten the planning state and ease the issue of complicated schedules. The traveller does not have to leave home/work until the right time, and will know that the bus will show up. The app would also facilitate the arrangement of arriving on time, especially if users would be able to tailor an entire trip potentially including multiple transport modes, but with a preset arrival time. Much like booking a long-distance travel ticket. To avoid the sense of high ticket costs in public transport, processing the travel purchase within the app is a solution, much like today's mobile ticket when buying online. The relative time difference between bus and car is reduced and the number of actual decisions minimized (4.2).

One solution not found in any of the existing apps is real-time updates of individual vehicles in terms of *occupancy* e.g. available seating. Parents of small children with a bulky pram need information of buses with sufficient pram space, and travellers interested in working on the vehicle, or who simply want a guaranteed seat, are interested in if there are available seating etc. If not, they can stay inside and wait for the next bus.

Another solution that also could be both helpful for travellers and result in reduced emissions is a *parking assistance guide*. I assume that many car drivers get in their car and drive to the destination, hoping that there will be a free parking space. If it is a busy day, as it often is in

urban areas, they circle around the parking lots while regretting taking the car, working up an irritation and becoming more of a danger in the traffic. Say that one could check the parking availabilities at home beforehand, through the SUNSET app. This might encourage some travellers for certain urban distances, to instead take the bus. Besides, taking the car is likely to get you stuck in congestion, while taking the bus, given there are designated bus lines, might get you to your destination on time.

Apart from traffic, waste is a problem in urban areas as the population increases. Not all housings provide sufficient waste management, and many have to drive to waste disposal sites with bulky, hazardous or other odd wastes. Walking is often no alternative and neither is using public transport. Meanwhile, many countries, including Sweden, have a system of garbage trucks collecting household garbage regularly. A *garbage add-on* to the app would provide households with information such as when and what time the garbage truck is arriving, setting a reminder so as to meet them and send away hazardous wastes etc.

6.3.3 Effective time as a competitive weapon

Have you ever taken a metro and noticed the frequency of people reading? Everyday metro travellers in cities seem to always bring the news or a good book to read on the tube. I would think they enjoy that moment of calmness and effective time, and that some even see it as a reason for enduring the busy metro rather than taking the car to town.

The most frequent car drivers are middle-aged working men, habitual and indolent in their choice of transport. The trick, I would say, is to find an app that enables them to be even more indolent, especially in their seemingly needless car commuting to and from work. In the SUNSET project, the trilogy of smartphone technology, free Wi-Fi, and time spent in public transport can add up to effective time as a new competitive aspect of the urban life. Product values of smartphones seemingly interact with public transport policies and transport sustainability. The time saved on not having to plan ahead when choosing the car, might be gained also in public transport by the effective time on the bus, wired to Internet reading email, working or chatting with friends – activities not possible or safe while driving a car. As I have shown in section 4.3.1, we value different kinds of time differently, which indicates that effective time have a potential to be valued higher than say driving time.

There is also the potential of new business models or employer policies, to get travel time converted into working time, overtime or salary. The same procedure as when working from home, you simply register for the time spent working on the train/bus. A GPS-based verifying

system should be possible to develop. Since professionals often have a given travel pattern in terms of time and route, the planning will be easy and presets effective. The trick is to reduce the number of active choices and virtually provide a new carefree and indolent travel habit. These *portable workplaces* can further be improved by a work-mode of the SUNSET sustainable travel app, also suggested by Arnestrand (2011), of proposed public transport itineraries for every new appointment or meeting added to e.g. the Outlook calendar. Another solution is to couple the tailored itinerary to colleagues and friends in the area, heading the same way.

6.3.4 Entertainment

Many smartphone users have already seen travel planners and CO_2 calculators; the SUNSET app should be possible to turn into a more fun and exciting experience. Arnestrand (2011) proposes the concept of making the user challenge him-/herself or others by trying something new. This is done by e.g. *Många Sträckor Små* and *Commute Greener!* reviewed in section 5.4. A point system rendering points for each trip with public transport can be a fun way to challenge friends or colleagues, and when reaching a certain level of points you get a reward. Since the group of professionals has such large potential of reducing apparently redundant urban car traffic, the SUNSET objectives are suitable for in-house challenges or part of the business travel policy. In-house competitions where the best co-worker or work team acquires some sort of reward might pose an effective incentive. If families and children are involved, e.g. through school projects or competitions, it might be an even deeper incentive for car-driving parents to choose the bus. It would also be a way to encourage children to use public transport early, as mentioned in section 6.2.3.

If the points are tradable, a user in need of bus-points can switch them with someone else in the system for e.g. train-points. In aviation, points are used to reach different user levels, such as gold and platinum traveller. This can be another idea for a public transport system, where high-end travellers get beneficial travel fares etc.

Another aspect of fun is to invite to a game, or treasure hunt, e.g. scanning QR codes in different places and compete with other for a reward. This could be relevant for certain trips, e.g. with children or leisure. There can also be some sort of top chart of scores in terms of travel frequency or travel distance, as with *Många Sträckor Små*. GreenBiTs involve celebrities in the challenge, which is an interesting solution (5.4). The well-known profile might pose with a picture or quote, increasing the feeling of credibility. One should however be aware of the

risk of scandals and unpredicted events that hurt the reputation of the celebrity. These should all be add-ons, available for those who are interested, but not imposed on those who are not.

Considering the matter of individualism and collectivism in travel patterns mentioned in section 4.3.8, smartphone apps might increase the sense of collectivism in urban groups. Perhaps it is wise for app distributors to stress the benefits and communion aspects of social interaction in travel and travel planning. A connection to social media could further underline the collectiveness and give users support from friends and groups. From another perspective, smartphones with the possibility to stay connected for work and entertainment even on the trip is a way to ensure the personal private sphere and escape the intrusion of strangers, for those seeking to do so.

6.3.5 Rewards

In much of our behaviours, we want rewards and confirmations. Perhaps the actual reward is less important, if our results can give us other values, e.g. be shown in social media. As previously suggested, linking to Facebook can have an unforeseeable snowball effect. External rewards such as bonuses, coupons, or subsidised travel might be enticing to change travel behaviour, and trial periods in public transport have been proven to be. Theories that practically vested knowledge is more easily converted into actual habit change indicate that this initiated behaviour is more likely to continue. If members of the social sphere do the same, it might be difficult to retreat and go back to the previous i.e. the car. The scale can be turned – making public transport the obvious choice and the car the odd decision. A comparing example is the so called eco car grants and how the resulting rising sales of eco cars, turned their status from alternative to undisputable in many regions. Theoretically vested knowledge, information about the negative long-term effects of car traffic, has not had efficient effect thus far. I still think however, that such information must be intensely distributed to travellers, to secure a long-term understanding and valuation change. Perhaps most important to children. Travel patterns and general values and beliefs are shaped early in life.

An initial reward as positive stimuli can create a new habitual behaviour, according to behavioural theories in section 4.2. It is important to keep it a temporary invitation, however, if not to make the reward itself the only objective. To make the user associate the desired behaviour with something positive, the reward can be connected to the travel itself. Of the same reason, both the app and the public transport system need to live up to what is promised and expected of the newly attracted travellers. If this is not achieved, it is likely that the users re-

turn to their previous behaviour. Offering free Wi-Fi on the bus as a reward is relevant only for those interested in using their IT tools on the bus. Many buses are besides likely to offer free Wi-Fi in the future.

6.3.6 Direct feedback

Direct feedback on our behaviour is important for our perception and contentment and thus our motivation to act, according to cognitive theory in 4.2. The app can facilitate direct feedback in several ways, perhaps best in terms of costs, both time and money, enabling comparisons and perhaps convincing the user of the ultimate travel. A calculation can be achieved by using the GPS-function reading the distance between A to B and with a standard value of fuel price, average car costs etc. This is then compared to the standard cost for taking e.g. the bus the same distance. In the end of the month, one might get a total to further reinforce the message; potential benefits for the personal budget black on white. The user should be able to choose exactly which routes to be calculated, since certain trips are unavoidable.

The categorization made by Wardman & Ibáñez (2011) on time valuation of traffic holdup (4.3.1) would be interesting to see for alternative transport modes and perhaps a factor to include here. If the SUNSET app can give the present traffic jam situation for the planned route, on a similar time-valuation scale, and compare it to the expected time of taking e.g. the tram, it might serve as a strong incentive to leave the car. Time can also be calculated in terms of actual time spent in public transit and translated into the previously mentioned effective time. This is then combined with the corresponding time spent behind the wheel as inefficient time.

Since environmental concern has little influence on how we chose to travel, it is sensible not to solely emphasize the green values of changed travel behaviour, but rather point at other values and incentives. Nevertheless, calculating the spared CO_2-emissions from public transport travels can still be a good idea. According to Krech et al.'s (1962) theories, our readiness to act is high for measures where we feel that our own efforts can be effective and have impact. The information will acknowledge that the user is contributing to something bigger than the personal sphere, and perhaps be interesting to share in social networks.

The safety of public transport compared to passenger cars or motorcycle, in number of deaths per statistical trip might be sound to indicate in the SUNSET sustainability objectives, perhaps by simply accentuate the fact or through some kind of calculation or life-saving-challenge. It can pose as a considerable cost for many drivers, especially with children, making another transport mode more rational.

6.3.7 Customized solutions

Add-on solutions to the app will enable customization and coincide with the identified habitual behaviour and a preference to avoid active decisions. Maybe a *family-mode* add-on can be available for download, allowing more than one travel pattern. In the aspect of combined everyday errands, the app could show a collective solution for each family member, e.g. that four persons leave the same address simultaneously and need alternatives to different locations. To assist families with school children, this mode might also come with a *school bus add*, enabling parents to register when their children e.g. are on the bus or arrive to and from school. The app can also be used to encourage families and individuals to shop with aforethought, contributing to a win-win situation between food handling and transport as mentioned in section 4.3.4. An alternative is to give suggestions of apps providing this service, such as the Swedish Society for Nature Conservations Green Guide, which also gives information on red-listed species or other important consumer aspects (SSNC, 2011).

An add-on addressing elder is another suggestion, considering the rising volume of frequently travelling, mobile-using, older people in Europe. Finally, a *work mode* or the possibility of a shared user might entice businesses to collectively use the SUNSET app in-house (6.3.4).

Another custom-made interface is *favourites*, e.g. often visited friends addresses, most regular trips etc. One can chose a friend or store/company from a list, e.g. by a thumbnail picture as on Facebook, and thus reduce the amount of annoying manual writing described in section 5.1. A full GPS-adjusted travel route will be suggested, with the most frequently used mode or by other preferences such as the quickest or cheapest alternative – attuned by the user. The user should also be able to decide what information will be provided; the optimal route in regards to proximity, or perhaps a certain transport mode only. Another solution is to offer a list of entertainments based on what the user usually likes to do, such as a link to most read newspaper, social media, shopping sites, email inbox, iTunes etc.

6.3.8 Weaknesses

There are naturally weaknesses in using smartphone apps to carry out sustainability objectives. Perhaps most obvious, the traveller must have and use a smartphone, and chose to download the particular app. As previously said, however, the market share of smartphones and mobile computing platforms is substantial and most likely to be more or less universal in short. Attracting users to the app is a matter of product development and advertisement, discusses in section 6.3.1. The SUNSET/ISET objectives will certainly not reach all travel

groups, e.g. drivers of company cars and trips made within the business model. It is not unthinkable though, that a successful project gaining interest and followers in urban travel, will influence employers and perhaps create an interest in altering the in-house travel policy.

Integrity is another issue, when discussing tracking users on their mobile personal device. Here, the choice of consignor behind the message could increase integrity and security for users, e.g. a mobile operator with an existing relationship to the customer. On the other hand, social media seems to have generally contributed to lessen the importance of privacy. We post highly personal photos and information through these channels, and technology is a natural part of much of our lives today.

7. Conclusions and recommendations

7.1 Meeting the challenge

Urban Europeans have to travel less by car and use public transport more frequently, if EU is to reach the 20-20-20 Kyoto commitments, fulfil the goals in the Lisbon Strategy, and evade further aggravation of environmental degradation and climatic impact (1). No present policy measure or technical progress will alone create sufficient environmental relief. The costs of passenger car travel have to be raised through policies, and the perceived benefits lowered. Parallel, the costs and obstacles for alternative transport should be lowered and the benefits largely increased (4.2). Demand side measures and Mobility Management (MM) has documented effectiveness and is a step in the right direction, but additional effective ICT tools are requested (2.1). Smartphone applications provide maybe the most powerful way of advertising yet developed and have an interesting potential (5). They place the travellers in charge of the traffic system rather than the other way around, which can result in completely new structures. Mobile phone use is over 95% in Europe, access to mobile internet is increasing and smartphones continue to increase their market share, why that should not be a factor influencing action (5). In this thesis, I have identified how apps are best used within the EU SUNSET and Swedish ISET projects in particular, to support this development of more sustainable urban travel patterns (1).

Changing travel patterns is to change lifestyle; can an app? Looking back, computers changed our lifestyles. Mobile phones changed our lifestyles. Social media changed our lifestyles. Why not apps? App successfulness to change behaviour is high (5.1), and on the basis of this paper I say they have a fair chance of succeeding. However, only if combined with deeper structural and political incentives both in strategies and implementation. Collaboration is central to keep everyone happy (6.1.1). The capacity of public transport have to increase if we want more people to use it, and its performance and quality be improved in vehicles, systems, stations and platforms. Enough seating, free Wi-Fi and enough receptacles are further needed. Urban and infrastructural planning has to be guided by a focus on public transport rather than feeding the present car-dependency and listening to obsolete economic paradigms. State policies need to assist private transport companies and merchants and sellers in this e.g. through investments and tax reductions. Perhaps travellers can get a discount with local stores with their public transport receipt (6.1.1).

7.2 Attracting motorists to choose public transport more often

Apps are pull- rather than push tools – we chose them ourselves – and the challenge is to also attract motorists without prior interest in public transport. The trick, I would say, is to find app solutions that enable the user to linger within his/her comfort zone despite an altered travel behaviour, or at least make the transition as easy as possible to boost readiness-to-act (4.2). In smartphones and apps, the users can get more contextual information to back their decisions than previously possible, which according to theory makes them more rational. In addition, the decision making is even more rationalized since the processing of the information can be left to a fully rational computer.

The most frequent urban car drivers – highly educated middle-aged working men – should be the primary target group for the app. I urge however a readiness for future large travel groups (4.1.2 and 6.2). The target group travels most frequent, short distances, in a regular pattern, has a solid income and likely a smartphone. I conclude that their travel often is habitual and not always logically rational in terms of time and money (6.2.1). In weighing costs and benefits; relative time, comfort/convenience, and relevance to the daily chores constitutes the travellers budget rather than factual time or money. Freedom of choice is in many aspects essential. Allocation of this travel budget is affected by both internal barriers, such as force of habit and social acceptance, and external barriers such as structural limitations and poor performance of public transport (Figure 5, 4.3). I say the rationality model of human behaviour used by ruling economic theories is much too simplified in the sense of travel patterns. This behaviour is rather a matter of subjective perception and the rationality of habits reducing decision-making and planning. Incentives most important for rational drivers and potentially able to make them chose public transport, are on the basis of my material (4.4.1 – 4.4.8): **maximized effective time (reduced waiting time), structural improvements (available seating, more fares and closer stops) and high convenience to the daily chores**. Other are:

- predictability/punctuality through clear schedules and information
- the aspect of freed own-time and entertainment
- tax incentives and monetary advantages
- individualism and social status

My studies determine that environmental concern is not a sufficient incentive or argument for choice of travel mode, neither in empirics nor psychological theories (4.3.7). Additional empirics of travellers' opinions can e.g. be attained through surveys suggested in 6.1.3.

7.3 App functions, designs and contextual conditions

While driving a car, you cannot use your smartphone. You can in a public transport vehicle. The target group of habitual working men might be convinced by the argument of portable workplaces and effective time (6.3.3). Wired to the Internet, you can work, email, and network with others on your way to work, or engage in more analogue pastimes as reading. Your time spent working on the bus/tram might convert to overtime or salary from your employer.

Much effort of public transport is removed if the app provides full real-time information on bus lines, seat availability and departure/arrival and the possibility to book multimodal tickets through preset favourites. The app have to let drivers stay indolent or become even more so by freeing them of explicit decisions. A free start-up travel card with the local public transporter, and discounts with your local merchants are initial rewards that, as suggested by cognitive theories in section 3.2, might breach your threshold of reluctance. If the app also gives you direct feedback of costs and amount of time compared to the car, invites you to challenge others, display your scoring on Facebook, participating in an in-house competition at work or involving your children – perhaps you tag along. The app should create a relevant value for the user, based on needs or the attractiveness of innovation. You do not have to fill up the car, get late in the congestion, circle to find a parking space or be a part of the highest risk group of traffic fatal accidents (6.3.2). You are soon likely to have changed your attitude on public transport, which is an important start, and probably more prone to take the bus again. If others in your social sphere do the same, it is more difficult to return to the old habits. The depicted scenario is naturally dependent on a virtually impeccable performance of the product, the public transport, as well as a close collaboration between the developers of the app and public transport (6.1.1 and 7.1). It is also vital that the interface is clear and easy to understand and functions quickly to start and run. The app should utilize the mobile experience.

Specific app functions suggested to assist everyday travel and increase use of public transport are listed below (section 6.3). Some of these functions already exist on the market (5.4).

- comprehensive route maps and directions, at least what is offered on the market (5.4)
- booking multimodal tickets with a set arrival time
- automatic presets and favourite itineraries to reduce manual handling
- real-time updates of delays and occupancy on vehicles
- interaction: challenges, point systems, competitions and entertainment. E.g. used by *Många Sträckor Små*, and *Commute Greener!* (6.3.4 and 5.4)
- connection to social media, such as Facebook, enabling networking to increase behavioural influence by response mechanisms and learning from others
- customized add-ons (e.g. family- or work modes and favourites) to attract certain user groups, piece together complex combined daily chores and optimize the effectiveness of the app (6.3.7)
- specific functions such as parking assistance guide, shop assistance, traffic jam updates, school bus- and garbage truck add-on

I suggest the app is best distributed without an explicit consignor, to avoid any pre-valuation of the content, and spread through the same channels it is coupled to, e.g. through inviting friends on Facebook. There are a number of interesting ways to distribute it, e.g. enclosed in the smartphone or subscription from the start (5.1), distributing each add-on separately and invite to updates, or translate the SUNSET/ISET objectives into a business model where the service is bundled with e.g. credit card use to make it self-selling (6.3.1). I also believe it would be successful to invite companies to use the app, since the group of professionals has large potential to create environmental relief by altering travel mode (4.1.1). There is also an interest for planners in the previously unseen blueprint of what people want and need in their travel, enabling optimal use of material, time, money and resources ().

The passenger car's firm grip of European cities is still the recurring challenge for planners and developers, despite multiple national and international actions. My scenario in this thesis, of using smartphones and apps to create a more sustainable urban transport system, might contribute to and be helped by the trends of collaborative consumption (4.3.8). Whatever term is used, it is a development of true importance to sustainable urban transport – away from private ownership and management ruled by outdated economic theories of what people need and want. Modern problems need modern solutions. Smartphone apps are indeed a policy tool worth trying to master the challenge.

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Kramers, Anna (2011), PhD student at KTH Royal Institute of Technology, Centre for Sustainable Communications, Stockholm. Telephone interview.2011-12-14

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Appendix 1

Table 3 Quantitative data

Author and study	Basic data
Lindén A-L – Environmentally Conscious Citizens and Green Politics Book, 2004 Formas	The empirical material derives from several research projects Lindén has been involved in, published in international science journals, books or research reports.
Lindén A-L and Carlsson-Kanyama A – Present lifestyles in Future Perspectives Research Report, 1998 Dept. of Sociology, Lund	One of the materials for the Climate Delegation's future study. Empirical data is derived from RVU 1996 (interviews with 45 000 people for five cons. years) and SCB 1997.
Lindén A-L – Environmental Effects of the Public Book, 2001	All data based on her previous research in the national research program "Utvägar"
Lindén A-L – Human and Environment Book, 1994	Basic material from classical and modern sociology theories. Empirical data from processed existing statistics, research and qualitative interview material.
Bellman S et al. Article, 2011	A literature review gave rise to four theses, tested in empirical interviews with 228 people in the US and Australia.
Dell'Olio et al. – The quality of service desired by public transport users Article, 2011	A study based on three unlabelled stated preferences surveys in Santander, Spain, of what users and potential users of public transport expect and want from the services. The surveys were conducted both on board buses and at the bus stops, thereby accessing a wide spectrum of users, and provided 864 observations.
Eliasson J – Mode choice determinants Report, 2001	VINNOVA interviewed in 1999 travellers in Stockholm, Sweden, on how they reason about their choice of transport. The study comprised several parts, resulting in 1700 usable answers. A comprehensive explanation of the methodology can be found in Eliasson's material.
Flash Eurobarometer 206b – EU Transport Policy The Gallup Organization, 2007	A survey covering all 27 Member States on a randomly selected sample of over 25 767 ind. >15 years of age.
Waldo Å – Town and Travelling Doctoral Dissertation, 2002 Dept. of Sociology, Lund	In-depth interviews during two periods 1998, with 25 households in Malmö, Sweden. In-depth interviews with 22 politicians and professional planners in Malmö.

Appendix 2

Table 4 Consulted professionals

Name	Authority	Contact
Adell, Emeli	Techn. Dr. at Trivector, Lund (e.g. sustainability issues/CSR, IT, software, transport)	Personal interview at Trivector, Lund, 2011-12-07
Arnestrand, Elias	Business Developer at Samtrafiken, Stockholm	Telephone interview, 2011-12-13
Kramers, Anna	PhD student at KTH Royal Institute of Technology, Centre for Sustainable Communications, Stockholm	Telephone interview, 2011-12-14
Lindén, Anna-Lisa	Professor Emerita, Dept. of Sociology, Lund University (Consumption and everyday life; Energy, environment and climate; Lifestyle, consumption and green politics; Urban sociology)	Personal interview at Sociologen, Lund, 2011-11-28
Waldo, Åsa	Researcher (Environment, energy, attitudes, travel behaviour, lifestyle, everyday life, urban sociology)	Personal interview at Sociologen, Lund, 2011-11-24

Appendix 3

Table 6 Use of mobile phones, EU27 and Sweden (Eurostat, 2011c)

Last update: 27-05-2011
UNIT: Percentage of individuals
INDIC_IS: Individuals who use a mobile phone

GEO / TIME / IND_TYPE	EU27 2008	Sweden 2008
All Individuals	87	95
Individuals, 15 years old or less	:	:
Individuals, 16 to 24 years old	97	98
Individuals, 25 to 34 years old	96	98
Individuals, 25 to 54 years old	93	97
Individuals, 35 to 44 years old	93	97
Individuals, 45 to 54 years old	89	96
Individuals, 55 to 64 years old	79	93
Individuals, 55 to 74 years old	72	90
Individuals, 65 to 74 years old	62	84
Individuals, 75 years old or more	:	:
Males, 16 to 24 years old	96	97
Females, 16 to 24 years old	97	100
Males, 16 to 74 years old	88	95
Females, 16 to 74 years old	86	95
Males 25 to 54 years old	93	98
Females 25 to 54 years old	92	97
Males 55 to 74 years old	75	90
Females 55 to 74 years old	69	89
Employees, self-employed, family workers	94	97
Students	97	98
Retired and other inactive	72	88
Unemployed	86	94

No footnotes available. Special values: **-** not applicable or real zero or zero by default
0 less than half of the unit used **:** not available
Source of Data: Eurostat

Table 5 Individuals - Mobile Internet access, EU27 and Sweden (Eurostat, 2011d)

Last update: 14-12-2011
UNIT: Percentage of individuals
INDIC_IS: Individuals accessing Internet through a mobile phone via UMTS (3G)

GEO / TIME / IND_TYPE	EU 27 2010	Sweden 2010
All Individuals	8	20
Individuals, 15 years old or less	:	:
Individuals, 16 to 24 years old	13	31
Individuals, 25 to 34 years old	14	34
Individuals, 25 to 54 years old	9	24
Individuals, 35 to 44 years old	9	24
Individuals, 45 to 54 years old	5	15
Individuals, 55 to 64 years old	3	10
Individuals, 55 to 74 years old	2	6
Individuals, 65 to 74 years old	1	1
Individuals, 75 years old or more	:	:
Males, 16 to 24 years old	16	36
Females, 16 to 24 years old	11	26
Males, 16 to 74 years old	10	26
Females, 16 to 74 years old	5	14
Males 25 to 54 years old	13	32
Females 25 to 54 years old	6	16
Males 55 to 74 years old	3	9
Females 55 to 74 years old	1	4

No footnotes available
Special values:
- not applicable or real zero or zero by default
0 less than half of the unit used
: not available
Source of Data: Eurostat