Smidig Mobilitet i Oslo

L6.2 Acceptability of reporting travel data in a mobile application

Versjon 1.0

Dato: 2014-10-22

Oslo kommune

Prosjektet er støttet av:

Revisjon

Versjon	Revidert av	Beskrivelse	Dato
0.1	Marianne Elvsaas Nordtømme	Utkast 1	27.05.2014
0.2	Kristin Ystmark Bjerkan	Utkast 2	02.07.2014
0.3	Marianne Elvsaas Nordtømme	Utkast 3	02.07.2014
1.0	Kristin Ystmark Bjerkan	Endelig versjon	22.10.2014

Contents

1 Introduction

Transportation poses a significant challenge towards reaching climate goals related to reduction in greenhouse gas emissions. In 2012, road transport accounts for 23 % of CO2 emissions in Norway and has become an increasingly prominent source of emissions (Norwegian Environment Agency et al. 2014). As a response, Norwegian authorities seek to shift increases in urban passenger transport demand from car driving to public transport, cycling and walking (White Paper No. 21 2011-2012). The potential for increased public transport in urban areas is significant. More than half of all week day travels in the largest urban areas in Norway are made by car, and the share of public transport travels varies greatly among cities (Engebretsen and Christiansen 2011). Between 11 and 25 % of travels in large urban areas are made by public transport (Vågane et al. 2011).

Succeeding in shifting urban travel from car to public transport highly depends on the demand for public transport. More market-oriented and competitive public transport depends on a clear understanding of travel behaviour (Beirão and Cabral 2007). Research which investigates demand for public transport typically considers time values, fares, and service quality (Paulley et al. 2006). Additionally, evaluations of public transport have stressed travel times, frequency and reliability. Public transport reliability is typically characterized by excessive waiting times related to scheduled departures and excessive in-vehicle times caused by traffic conditions or problems located with the transport operator. Still, challenges related to reliability are not only related to waiting time per se, but also uncertainties related to *when* transport will arrive (Bates et al. 2001, König and Axhausen 2002).

The research project Smooth Mobility in Oslo (SMiO) aims to develop a solution for collecting travel information which could be used for identifying problem areas in the public transport system. The project seeks to produce supplementary data on the travel patterns of the public transport patronage and optimize public transport in terms of i) capacity and scheduling departures, ii) access time to/from transit stop, iii) waiting time, iv) interchange time, v) delays and vi) prevalence of combined and composite travels. The project aims to develop and demonstrate collection of travel data. Data is voluntarily reported by travellers through a GPS-based application for smartphones, which the traveller activates and deactivates at the beginning and end of each trip. The traveller can then choose to upload all registered trips, contributing to a collection of data which combined describes the operation of the public transport system. Eventually, it could be a valuable aide in technology assisted travel surveys (see Kohla and Meschik 2013, Stopher et al. 2013).

As a tool for optimizing public transport, the SMiO application represents a step towards more attractive public transport. As such, it could be considered a measure for promoting public transport usage. This supports policy goals related to traffic increases and shifts from car use to more environmentally friendly modes of transport. Additionally, by providing more accurate data to the public transport operator, the SMiO application will provide valuable input to existing planning tools in public transport. However, it requires active contribution from the traveller, which might reduce the inclination to use the application.

The purpose of this study is to describe the overall acceptability of the SMiO application, and to investigate factors which influence acceptability. This study asks i) *To what degree is the population willing to use the SMiO application* and ii) *Are there demographic groups that are less willing and thereby risk underrepresentation* and iii) *What factors influence the acceptability of reporting travel data to optimize public transport?* Understanding such factors is crucial for estimating potential barriers in full-scale implementation of the application and in anticipating actual usage when implemented. High usage is conditional for the SMiO application to serve as a planning tool in public transport.

2 Acceptability of travel registrations via mobile application

Acceptability is a widely studied subject within transport research. The interest in describing and/or explaining attitudinal phenomena can be seen in light of the recognition that policy formulation takes place in a two-way dynamics between authorities and the people (Vlassenroot 2011).

User acceptability of the SMiO application is both related to technology acceptance as well as measure acceptability. While technology acceptance refers to an individual's experiences with a particular technological application, measure acceptability concerns attitudes towards a measure not yet experienced.

A large number of models and theories seek to explain individual acceptance of technology: theory of reasoned behaviour (Fishbein and Ajzen 1975) and planned behaviour (Taylor and Todd 1995), motivational models (Davis et al. 1992), the model of PC utilization (Thompson et al. 1991), innovation diffusion theory (Moore and Benbasat 1991) and social cognitive theory (Compeau and Higgins 1995). Perhaps most widely recognized is the Technology Acceptance Model (TAM) (Davis 1989). TAM is considered a robust model for predicting user acceptance of technology, and typically explains approximately 40 % of variations in usage intentions (Venkatesh and Davis 2000). The TAM model suggests that usefulness and ease of use predict technology use, but that use is moderated by attitudes and intentions (Mathison et al. 2001). In their proposal of a unified theory of acceptance and use of technology (UAUT), Venkatesh and colleagues (2003) select four explanatory constructs: performance expectancy, effort expectancy, social influence and facilitating conditions.

Even though a large number of surveys have used GPS to collect travel data, quite few have reported response variations and willingness to participate among users (Stopher 2008). A small number of studies indicate a typical response rate of approximately one third (Roux et al. 2009, Stopher et al. 2008). However, response rates are difficult to measure, as recruitment to GPS based travel surveys is often conducted within the framework of traditional travel surveys. As such, the willingness to participate in surveys similar to the SMiO application is often skewed.

Few studies report user acceptance of collecting GPS based travel data. Most studies are concerned with the technological implementation of data collections such as the SMiO application, and devote little resources to users. Certain studies show, however, that willingness to track travels is higher in households with high income, households with more than one car and high-tech equipment, younger age groups, and in men (Hawkins and Stopher 2004, Roux et al. 2009). This could be an indirect estimate of the technological acceptance, but this relation has not been explicitly reported.

In this study, theories of technological acceptance are less relevant as the SMiO application is considered a measure for improving public transport rather than a technological device. Also as the application was yet not developed at the time of this study, it is concerned with a priori assessments of the SMiO application. As such, emphasis lies on explanatory factors in relation to measure acceptability. One can expect a certain co-variation between technological user acceptance and measure acceptability, and technological acceptance might very well serve as an explanatory variable of measure acceptability. In anticipating the completion and roll-out of the application, however, this study does not yet have sufficient data for examining such correlations.

2.1 Measuring acceptability

Studies on acceptability mainly serve to bring up unintended consequences and to substantiate whether the implemented measure will have the anticipated effect. Despite that acceptability is a well-recognized subject, the body of research has not been able to provide a clear and uniform definition of the concept or how to measure it (Schade and Schlag 2003, Vlassenroot et al. 2010). This study employs the definition of acceptability as presented by the CURACAO project in their final report to the European Commission, referring to acceptability as relevant stakeholders' *attitudes and prospective judgments of proposed schemes* (Schade and Obst 2009:152). It further distinguishes between *acceptability* as an attitude construct which describes the prospective judgments of measures to be introduced in the future, and *acceptance* as attitudes and

behavioural responses after the introduction of a measure (ibid. p.154). The latter might converge with technological acceptance, but is not considered in this study. Anticipating the acceptability of the system for reporting travels requires insight into factors which facilitate and influence the acceptability among travellers. A vast amount of literature aims at explaining the acceptability of transport policy measures, and different studies emphasize different influences. Schade and Schlag (2000:8-9) refer to eight different factors associated with acceptability: i) problem perception, ii) important aims to reach, iii) information and awareness of options, iv) perceived effectiveness and efficiency, v) the individuals car-orientations, vi) revenue allocation, vii) equity and fairness, and viii) social norms and behavioural control. Their refined model (originally published in Schlag and Teubel 1997) represents one of few attempts to synthesize different approaches to acceptability in one coherent model.

Problem perception refers to a traveller recognizing the problem which the measure is intended to solve. In this study, this relates to understanding challenges to public transport in urban areas. It could also refer to the individual's experiences with public transport and their subjective opinion on areas of improvement. *Scheme perception* mainly refers to the individual's knowledge and understanding about the proposed scheme. It is not necessarily the actual design of the scheme which influences acceptability, but rather the perception or imagined functioning of the scheme. Gaunt and colleagues find, for instance, that misconceptions over scheme designs might significantly influence acceptability levels (Gaunt et al. 2007).Further, the acceptability of a given measure heavily depends on its effectiveness and efficiency. Schade and Schlag (2000:13) define *effectiveness* as the degree to which the aims of the measure can be reached, whereas *efficiency* refers to the cost-benefit-relation compared to other measures. They further contain that because of the complexity of measuring efficiency, most acceptability research has focused on effectiveness. This is also the case in this study.

Fairness and equity are interrelated, and transportation equity refers to "the question of fairness in access to road infrastructure" (Viegas 2001). More specifically, equity implies that everyone gets an output reflecting his or her input (Schade and Schlag 2000:14). Ittner and colleagues (2003) refer to five aspects of policy measures which might reinforce the importance of fairness: i) the effectiveness of the measure, ii) possibilities to sanction incompliance, iii) probability of sanctions being imposed, iv) the fairness in the distribution of costs and benefits, and v) resulting personal benefits. Here, fairness relates to the expected outcome of reporting one's travels with the SMiO application. This is ultimately manifested in improvements in the public transportation system which benefits the individual traveller. This is highly related to *consequences to self*.

Consequences to self are considered a strong determinant of acceptability. According to reactance theory, the public will devaluate the attractiveness of forced policy measures which threaten their behavioural freedom (Baum 1999). Especially, it predicts acceptability will be reduced when people are convinced these measures will be implemented. Thus, acceptability is strongly related to the measure's perceived consequences to own situation, and there will be increased support among people who believe a measure will overcome a problem they feel personally affected by. This could be related to *protection motivation*: people will only adhere to a measure if it will shield them from personally experiencing negative consequences (Rogers 1983). People thus tend to be self-oriented in their evaluation and are more positive if they believe their lives will not be affected. In fact, Schuitema and Steg (2005) argue that the influence on own situation moderates increased acceptability induced by perceived effectiveness. They hypothesize that the effectiveness is only related to acceptability when it does not seriously affect one's own situation.

Attribution of responsibility is a product of norm activation theory (see Schwartz 1970) and is an important component in explaining altruistic behaviour. It distinguishes between i) responsibility for problem causation and ii) responsibility for solving the problem (Schade and Schlag 2000:17). Here, only the second attribute is relevant and might increase willingness to use the SMiO application. In using the public transport system regularly, and experiencing particular problems, the individual might consider it their responsibility to alert responsible actors about these problems.

2.2 Acceptability of the SMiO application: hypotheses

The purpose of this study is to describe the overall acceptability of the SMiO application, and to investigate factors which influence acceptability. Based on the theoretical understandings of acceptability presented above, six hypotheses are developed regarding expected results. The hypotheses represent theoretical causal factors for the stakeholders' acceptability of the SMiO application. This is illustrated by Figure 2-1: .

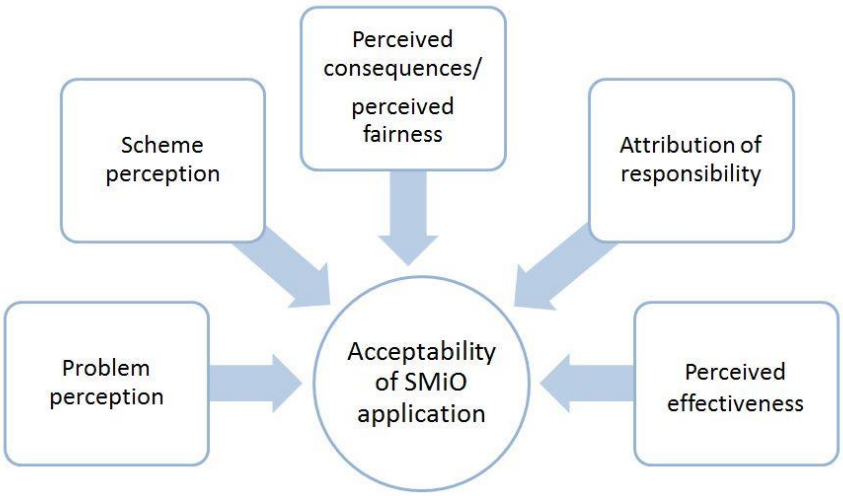

Figure 2-1: Factors hypothesized to influence stakeholders' acceptability of the SMiO application

H1. The acceptability of the SMiO application among potential users is low

H2: The acceptability is lower among potential users with a low problem perception

H3: The acceptability is lower among potential users with a low scheme perception

H4: The acceptability is lower among potential users who perceive the effectiveness of the scheme to be low

H5: The acceptability is lower among potential users who perceive the fairness of the scheme to be low

H6: The acceptability is lower among potential users with a low sense of responsibility

3 Methods

3.1 Sample description

Acceptability of and willingness to use the SMiO application were measured in an online survey. Respondents to the survey were recruited through a continuous omnibus conducted by the transport operator, Ruter. For a period of 4 months, participants in the omnibus were asked if they would like to participate in another survey online. Participants signed up by giving their e-mail address. E-mail addresses were forwarded to the researchers, and comprised 594 potential respondents. This resulted in 216 unique replies, indicating a response rate of 36 %.

Additionally, the survey was distributed via an open link on the home page of the transport operator. This resulted in an additional 619 replies, with a total sample consisting of 835 respondents.

Table 3-1:Sample characteristics (n=835)

	n	%
Gender		
Male	342	42
Female	477	58
Place of residence		
Oslo	548	66
Akershus	255	30
Other	29	4
Age		
Less than 20 years	82	10
20-29 years	278	33
30-39 years	198	24
40-49 years	128	15
50-59 years	93	11
More than 60 years	53	7
Education		
Elementary of no education	76	9
High school	228	29
College/university, lower degree	305	38
College/university, higher degree	188	24
Main occupation		
Employed	544	68
Student	177	22
Retired, disabled, unemployed	62	8
Other	15	2

Sample characteristics are presented in Table 3-1 and Table 3-2. Compared to the overall population characteristics of Oslo and Akershus, this sample stands out with regard to 4 particular variables[1]. For one, women are overrepresented in this sample, comprising 50 % of the general population (Statistics Norway 2014). Secondly, Oslo residents comprise 52 % of the inhabitants of Oslo and Akershus, whereas they comprise 66 % of the sample. Thirdly, people between 20 and 40 years of age are heavily overrepresented in the sample. In the sample they comprise 57 %, whereas they make out 36 % of the general population. Finally, respondents with college or university education dominate the sample. Whereas 41 % of the general population has a college or university degree (Statistics Norway 2012), this applies to 62 % of the sample. These skewnesses are taken into consideration when results are discussed.

Table 3-2: shows aspects of the travel behaviour in the sample. It shows that a large majority of the sample use public transit service 4-7 times per week, and that nearly all live less than 1 kilometre from the nearest public transit stop. Additionally, 92 % of the sample has a Travel Card. As such the sample could be considered quite resourceful: it is younger and more educated than the general population, and appears to have easy access to public transport resources. This is not surprising, considering that the willingness to participate in the survey would be greater among those who are using public transport quite actively.

Table 3-2: Sample characteristics, travel behaviour

	n	%
Travel frequency		
4-7 times per week	644	80
2-3 times per week	60	8
Weekly	45	6
Less than weekly	54	6
Distance to public transit		
Less than 500 m	511	64
500 m - 1 k	211	26
1,1 - 1,5 k	44	5
More than 1,5 k	39	5

3.2 Measures

Acceptability is measured by the question *How do you consider a potential system for reporting travel data by smartphone, as described earlier[2]?, 1=very negative, 2=negative, 3=neither negative nor positive, 4=positive and 5= very positive.*

The analysis of the survey includes explanatory variables based on earlier studies of variations in acceptability (as elaborated in chapter 2). These variables are problem perception, scheme perception, perceived effectiveness, perceived fairness and attribution of responsibility.

[1] See appendix for full

[2] See also Box 3-2.

Problem perception is measured by two sets of questions. The first set, labelled *Problem perception A*, consists of 9 items which the respondents were asked to rate according to their own content/discontent with public transport in Oslo and Akershus. Each item was rated on a scale from 1= very discontent to 5 = very content (see Box 3-1.).

How content or discontent are you with the following
Frequency of departures
Distance to transit stop from home/school/work
Punctuality
Route scheme
Opportunities for interchange
Waiting time at transit stop
The routines for comments and feedback to the transport operator
Comfort on board
Opportunity for direct travel (without interchange)

Box 3-1. Problem perception A (low=1, high=5)

The second set of items, labelled *Problem perception B*, is related to respondents' opinion on the overall functioning of the public transport system in Oslo and Akershus. The respondents gave their take on statements as listed in Box 3-2. , where *1=strongly disagree, 2=disagree, 3= neither agree nor disagree, 4=agree and 5=strongly agree*.

Do you agree with the follow statements
I know the transport operator's vision and business idea
The transport operator offers attractive and environmentally friendly public transportation
Public transportation is easy to use
Public transportation gets me where I want to go in an efficient manner
Public transportation is appropriately designed
The transport operator is unfamiliar with the problems in public transportation
The transport operator has inadequate knowledge about the needs of travelers

Box 3-2. Problem perception B (low=1, high=5)

As both sets of questions for estimating problem perceptions correlate significantly with acceptability, they are combined into a single index for problem perception. Only items with correlations between 0.3 and 0.6 are included, and italic items in Box 3-1. and Box 3-2. are omitted from the index. Items values are reversed before indexing, allowing high values to indicate high problem perception.

In the regression analysis the Problem perception index is dichotomized into a variable **High problem perception** where *0=low problem perception* (0 thru 2) *1= high problem perception* (3 thru 5).

Scheme perception is measured by the question *Do you find the above explanation easy to understand?, 1=very difficult, 2 =difficult, 3=Neither difficult nor easy, 4=easy, and 5 =very easy.* Replies are recoded into three groups indicating low, moderate and high scheme perception.

> A pilot study now encourages the participation of users of public transport to voluntarily report their travel activities by use of their own smartphones. The purpose is to evaluate the potential for facilitating and improving public transport based on more precise information about travel patterns.
>
> Participants to the study download a mobile application which they activate at the start of each travel. This application registers the movements of the participants, and the participant can choose to report these registrations to a data base. Both the registrations and the data base are approved by the Norwegian Data Protection Authority.
>
> Among other things, these data can provide the transport operator with information about place specific bottlenecks in the transport system, which facilitates targeted measures for improving public transportation. The individual participants decide themselves what travel data they wish to report, and data cannot be traced back to the participants.

Box 3-2. Measure description

As the above question merely provides a subjective measure on scheme perception, another measure is included to control for the factual understanding of the scheme. Respondents rate their agreement with the following statement *The purpose of the measure described above is to collect more precise information about difficulties in public transportation*, on a scale where *1=strongly disagree, 2= disagree, 3= neither agree nor disagree, 4=agree and 5=strongly agree very much.*

Perceived effectiveness is measured by two statements which the respondents categorized according to their own agreement/disagreement with the statements: *The measure will provide the transport operator useful information* and *The measure described earlier allows my experiences to be taken into account*. For both statements *1= strongly disagree, 2=disagree, 3=neither disagree nor agree, 4=agree and 5=strongly agree*.

Perceived fairness is measured by one statement which the respondents categorized according to their own agreement/disagreement with the statements: *The measure will give me improved public transportation*, where *1= strongly disagree, 2=disagree, 3=neither disagree nor agree, 4=agree and 5=strongly agree*.

Attribution of responsibility is also measured by one statement which the respondents categorized according to their own agreement/disagreement: *The measure described earlier ascribe travellers too much responsibility for improving public transportation (reversed*), where *1= strongly disagree, 2=disagree, 3=neither disagree nor agree, 4=agree and 5=strongly agree*.

Table 3-3 summarizes explanatory variables related to scheme perception, perceived effectiveness, perceived fairness and attribution of responsibility. In the following, these variables are referred to as Scheme I, Scheme II etc.

Table 3-3: Summarized explanatory variables: scheme perception, perceived effectiveness and perceived fairness

Scheme I	Do you find the description of the measure easy or difficult to understand?
Scheme II	The purpose of the measure described above is to collect more precise information about difficulties in public transportation,
Effectiveness I	The measure will provide the transport operator with useful information
Effectiveness II	The measure allows my experiences to be taken into account
Fairness I	The measure will give me improved public transportation
Responsibility	The measure ascribes travelers too much responsibility for improving public transportation (reversed)

4 Results

4.1 Bivariate analyses

4.1.1 Travel behaviour

Nearly all respondents (92 %) report that they have a travel card, and most respondents are frequent users of public transport in the Oslo and Akershus area. Figure 4-1: shows travel frequency in respondents, and shows that 93 % of all respondents travel by public transit at least once a week. The majority travels nearly every day.

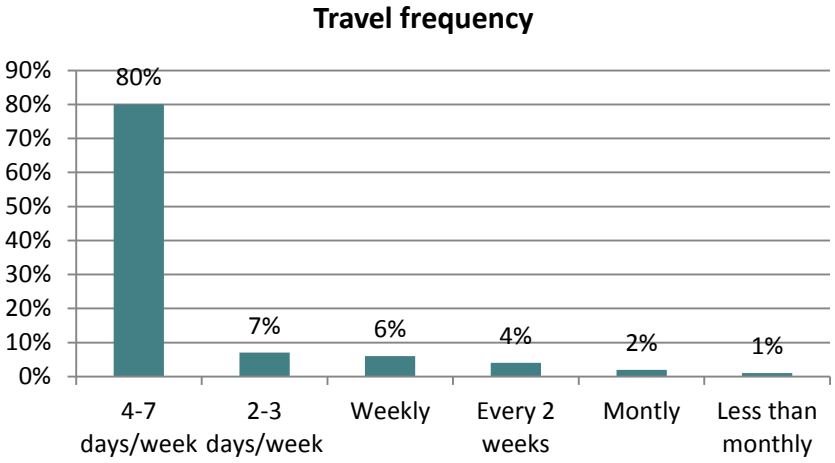

Figure 4-1: Travel frequency (n=803)

As seen in chapter 3, 64 % of respondents live less than 500 meters from a public transit stop, and 90 % live less than a kilometre from a public transit stop. To 68 % the stop nearest to their home is served at least 4 times per hour on weekdays, and only 13 % report that their stop is served less than 2 times per hour (Table 4-1: -1). Table 4-1: -1 further shows that half of the respondents normally travel by bus, and that 1 in 4 normally travel by metro.

Table 4-1: Frequency at transit stop (n=798) and means of transport (n=801)

	n	%
Frequency at transit stop 9am to 3 pm		
4 per hour or more	545	68 %
2-3 per hour	154	19 %
1 per hour	80	10 %
Every 2 hours	5	1 %
< every 2 hours	14	2 %
Means of transport		
Bus	414	52 %
Metro	212	26 %
Tram	78	10 %
Train	74	9 %
Boat/ferry	23	3 %

4.1.2 Problem perception

A central issue in measuring acceptability is related to problem perception. Figure 4-2: Problem perception shows respondent ratings of public transport in Oslo and Akershus, labelled Problem perception A. The figure shows that respondents are most content with the location of the transit stop nearest their home (80% content). Further, departure frequency (69% content) and transfer opportunities (65% content) receive positive ratings. Respondents seem little content, however, with the public transit operator's routines for comments and feedback (24% content).

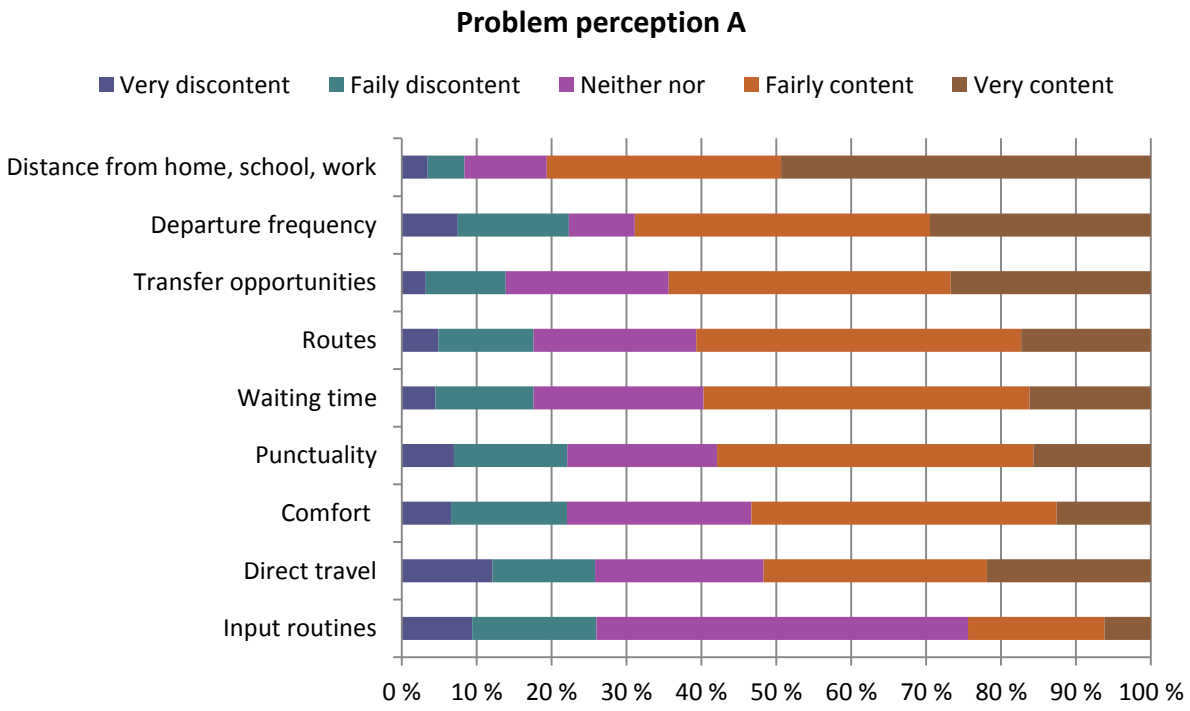

Figure 4-2: Problem perception A, percentage (n=796-803)

Figure 4-3:-3 shows responses to statements in Problem perception B. It clearly shows that nearly all respondents (90 %) agree that travellers should contribute with information and experiences to assist the transport operator in improving public transportation. Further, most find the public transport system easy to use (77 %), consider public transport to be efficient (61 %), attractive and environmentally friendly (65 %). However, few are familiar with the transport operator's vision and business idea (23%).

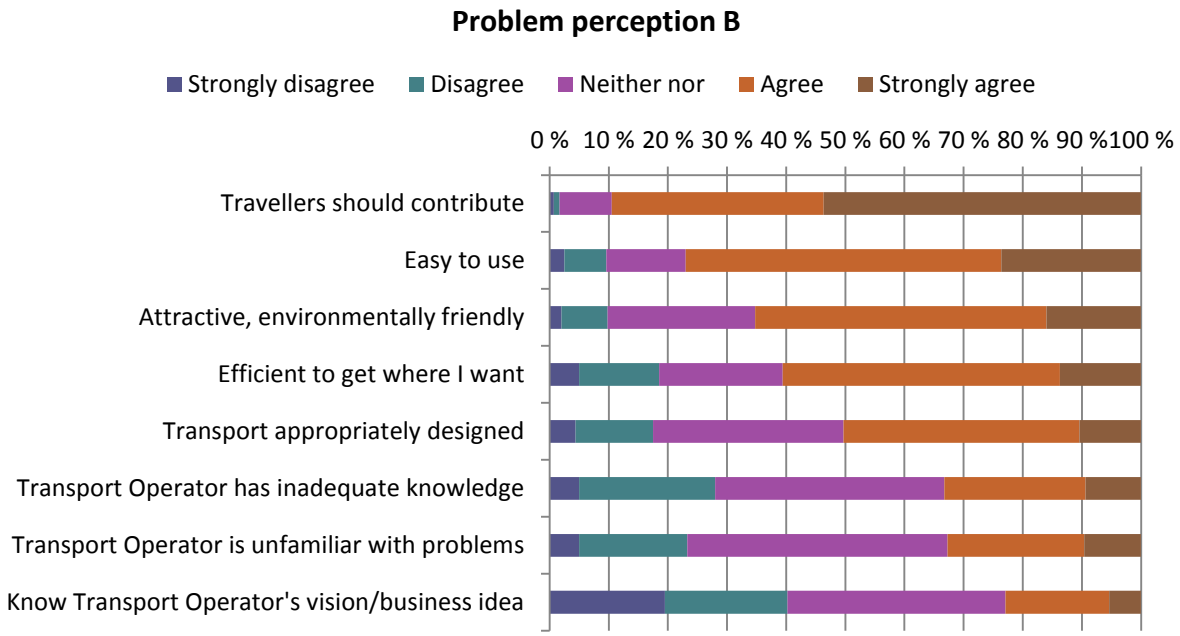

Figure 4-3: Problem perception B (n=798-803)

4.1.3 Scheme perception

Most respondents find the explanation of the measure (see Box 3-2) easy or very easy to understand (82 %), while quite few find it difficult or very difficult to understand (5 %). Crosstabs show that there are certain variations in scheme perception, mainly related to age and main occupation. High scheme perception is particularly dominant in the three youngest age groups, whereas low scheme perception is more widespread in age groups above 50 years. In fact, respondents with a high scheme perception are on 4 and 5 years younger than respondents with moderate and low scheme perception respectively.

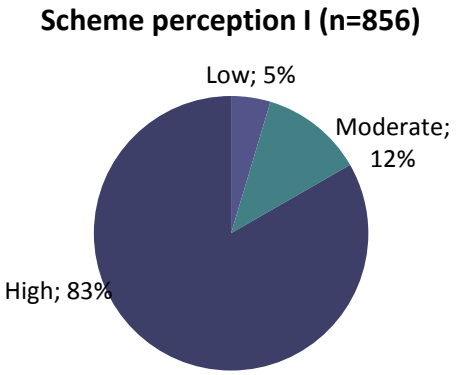

Figure 4-4: Scheme perception I (n=856)

Further, there is substantial variation according to main occupation. High scheme perception is heavily predominant in respondents who are employed (83%) and in students (88%), compared to respondents who are retired, disabled or unemployed (69 %) or of other occupation (58 %). There are also minor educational differences: respondents with elementary or secondary education tend to express lower scheme perception than other education groups. Given the relatively small group of respondents indicating low scheme perception (n=37) it is important to keep in mind that group variations have not been subject to tests of significance.

4.1.4 Perceived effectiveness

Perceived effectiveness is one of the factors assumed to have greatest influence on acceptability. Figure 4-5: shows perceived effectiveness related to i) providing the transport operator with useful information, and ii) allowing traveller experiences to be taken into account. The figure shows that respondents perceive the measure to be highly effective in providing the transport operator with useful information, but less effective in considering traveller experiences. As such, one could ask if the respondents doubt that the information provided the transport company will be used.

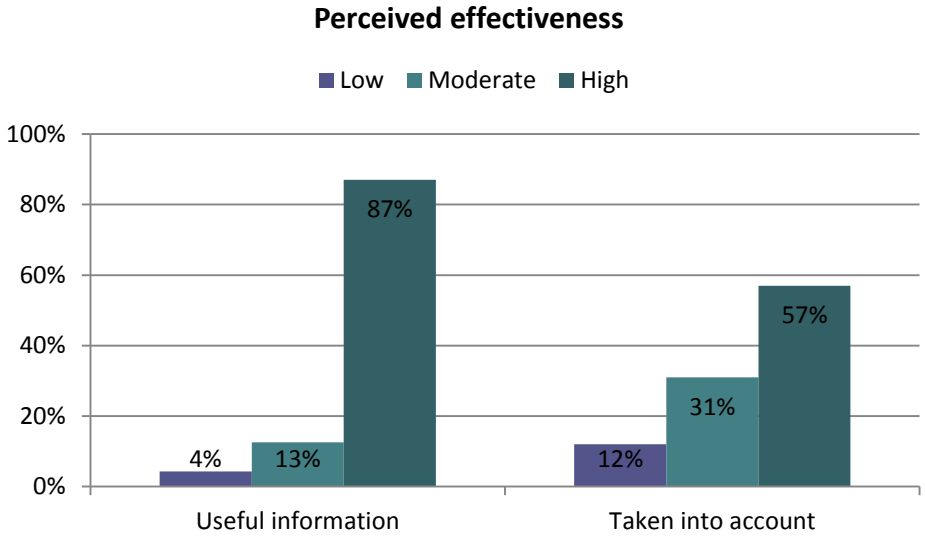

Figure 4-5: Perceived effectiveness. Providing transport operator with useful information (n=794) and Allow experiences to be taken into account (n=794)

There does not appear to be much variation in perceived effectiveness. Perceived effectiveness seems to be slightly higher in younger age groups both in terms of providing useful information and experiences being taken into account. Believing experiences will be taken into account is also far more prominent in respondents with elementary education or less, as well as in students. Further, perceived effectiveness in providing information is lower in respondents who are neither employed nor students.

4.1.5 Perceived fairness and attribution of responsibility

There appears to be greater variations in perceived fairness than in other explanatory variables. Figure 4-6: Perceived fairness and attribution of responsibility. Will give me improved public transportation (n=798) and Ascribes travellers too much responsibility for improving public transportation (n=798)

shows perceived fairness according to whether the respondents expect their inputs to results in improved public transport (fairness), and whether it ascribes travellers too much responsibility for improving public transport (reversed) (attribution of responsibility). The figure shows greatest variation in terms of the first parameter.

Perceived fairness, in terms of output reflecting the respondent's input, is higher in men and respondents with elementary education or less. Additionally, respondents less than 40 years old report higher fairness, while perceived fairness decline with increasing age above 40 years. When it comes to attribution of responsibility for problem solving, intra-group variations are minor. There are no apparent gender differences, but the sense of responsibility is lower in age groups above 60 years.

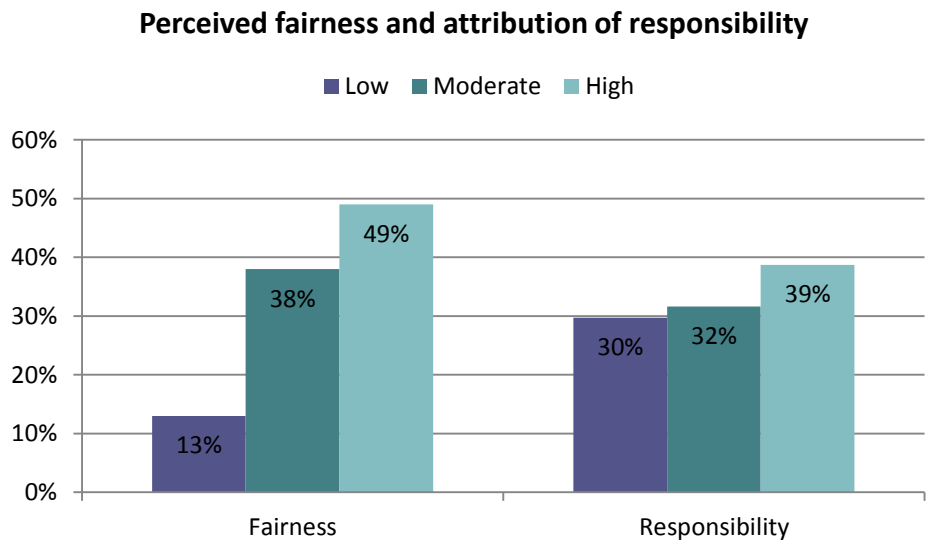

Figure 4-6: Perceived fairness and attribution of responsibility. Will give me improved public transportation (n=798) and Ascribes travellers too much responsibility for improving public transportation (n=798)

More than half of all respondents are positive to reporting their travel data by use of a mobile application. In total, 61 % of respondents report high acceptability (positive or very positive), whereas 19 % report low acceptability (negative or very negative). The remaining 20 % reports moderate acceptability. Additionally, 63 % of the sample is willing to participate in a trial with the SMiO application to report their travels.

4.1.6 Bivariate analyses

Table 4-2: shows average acceptability in respondent groups. The table shows men to have higher average acceptability (3.67) than women (3.47) Acceptability also tends to be higher in Akershus residents, and in the youngest age groups. There are no clear variations according to education. Respondents who are retired, disabled or unemployed report lower acceptability than others. This is, however, partly due to the correlation between age and main occupation (-.126, p<.001) and a higher average age in this group.

There are further small variations in acceptability according to the travel characteristics of respondents. Still, acceptability is lower in respondents who use public transport less than once a week and respondents whose nearest public transit stop is served less than every 2 hours. Acceptability is higher in respondents who normally travel by bus or train.

In terms of explanatory factors related to the proposed scheme for reporting travel data, acceptability is higher in respondents with high scheme perception, high perceived effectiveness, high perceived fairness and high attribution of responsibility. For all explanatory variables, average acceptability increases with increasingly positive evaluations of the scheme.

Table 4-2: Average acceptability (min=1, max=5) by respondent characteristics and travel behaviour

Gender		**Travel card**	
Male	3..67	Yes	3.54
Female	3..47	No	3.66
Age		**Travel frequency**	
Less than 20 yrs	3..73	4-7 t/w	3.56
20-29 yrs	3.61	2-3 t/w	3.69
30-39 yrs	3.64	Weekly	3.5
40-49 yrs	3.39	Less	3.43
50-59 yrs	3.56	**Distance to public transit**	
More than 60 yrs	3.16	Less than 500 m	3.57
Education		500 m - 1 k	3.5
Elementary or less	3.64	1.1 - 1.5 k	3.59
Secondary	3.52	More than 1.5 k	3.66
Coll/univ, low degree	3.59	**Transit frequency**	
Coll/univ, high degree	3.53	4 times/hr	3..55
County		2-3 times/hr	3..6
Oslo	3.51	1 time/hr	3..58
Akershus	3.65	Less than 1 t/hr	3.21
Main occupation			
Employed	3.55	**Travel mode**	
Student	3.60	Bus	3.66
Retired, disabled, unemployed	3.48	Metro	3.43
	3.69	Tram	3.47
Other		Train	3.47
		Ferry	3.36

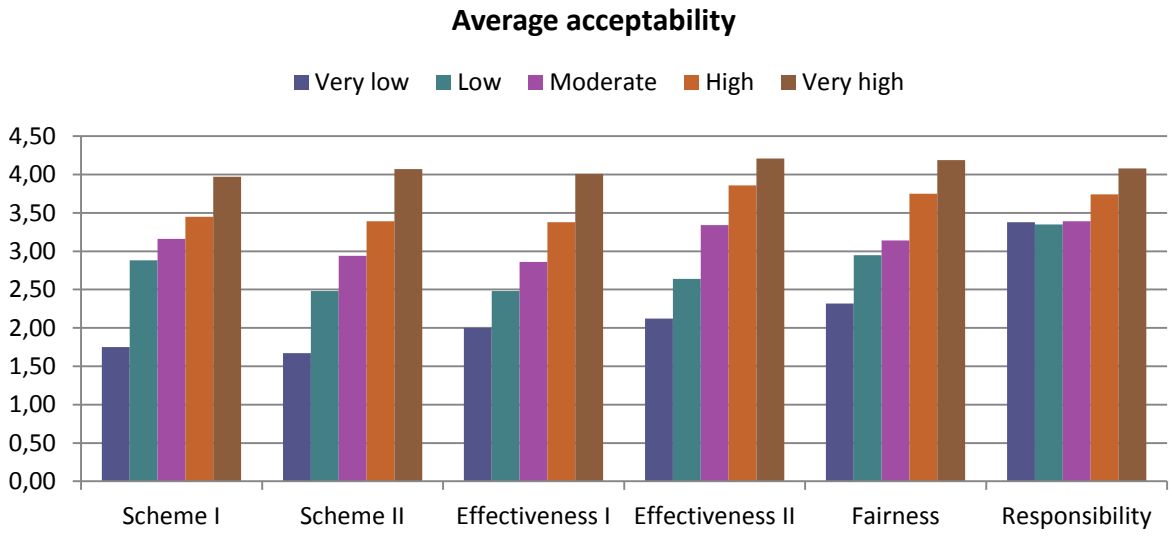

Figure 4-7: Average acceptability according to scheme perception, perceived effectiveness, perceived fairness and responsibility (min 1, max 5)

4.1.7 Regression analysis

In order to investigate the isolated effects of explanatory variables, a linear regression analysis was conducted. The original model included three sets of independent variables; respondent characteristics, travel behaviour and explanatory indicators. These are presented in Table 4-3: 4-3 which shows that respondent characteristics lose their significance when travel behaviour and explanatory variables are included. Both *Male*, *Age* and *Resident of Akershus* are significant in Block 1, but only Male remains in Block 3.

Table 4-3: Block model, all variables (n=737 R2=34.8)

	Block 1	Block 2	Block 3
Respondent characteristics			
Male	2.430***	2.392***	2.394***
Age	-.086**	-.08**	-.017
Resident of Akershus	1.631*	1.099	-.136
College or university degree	.706	.873	-.448
Student	-1.059	-.878	-.968
Travel behavior			
Has a travel card		-1.295	-.722
Main mode: bus		2.309***	1.877*
Travels less than weekly		-.300	0.27
Low transit frequency		-.003	-.001
Explanatory variables			
High problem perception			2.325***
Scheme perception I			2.446***
Scheme perception II			1.897***
Effectiveness I			1.317
Effectiveness II			2.268***
Fairness			1.610***
Responsibility			1.394***
Constant	21.088***	20.904***	-25.187***

*** p<.01, ** p<.05, *p<.1

Only one of the indicators of Travel behaviour in Block2 makes a significant contribution to the model, namely main mode of transport. The table clearly shows that explanatory variables related to problem perception, scheme perception, effectiveness, fairness and attribution of responsibility are strong predictors of acceptability. Slightly surprising, though, is the consistent lack of contribution to the model by respondent characteristics. Further, there is low or no correlation between respondent characteristics and explanatory variables.

All significant contributors to the model are included in 4-4. The table shows that problem perception, scheme perception I and effectiveness II are the strongest predictors of acceptability. Attribution of responsibility

seems to be the weakest predictor. Confidence intervals of the individual variables are generally large, with the exception of scheme perception and fairness.

Table 4-4: Final model: regression analysis of Acceptability (n=712, R2=36.6)

	B	Std.err	P	CI 95 %
Control variables				
Male	2.497	0.703	<.001	1.116-3.878
Travels by bus	1.785	0.694	.010	0.422-3.149
Explanatory variables				
Problem perception	2.552	0.842	.003	0.898-4.206
Scheme perception I	2.488	0.452	<.001	1.601-3.375
Scheme perception II	1.955	0.545	<.001	0.884-3.026
Effectiveness I	1.245	0.537	.021	0.191-2.299
Effectiveness II	2.532	0.528	<.001	0.449-2.456
Fairness	1.453	0.511	.005	1.495-3.568
Responsibility	1.242	0.301	<.001	0.652-1.833
Constant	-24.661	0.237	<.001	-29.348 - -19.975

4.2 Summarized results

H1. The acceptability of the SMiO application among potential users is low. In total 61 % of respondents report high acceptability of the SMiO application, and only 1 in 5 are negative or very negative. As such, H1 is rejected.

H2: The acceptability is lower among potential users with a low problem perception. The regressions analysis shows problem perception to be the strongest predictor of acceptability, with high problem perception indicating high acceptability. H2 is thus not rejected.

H3: The acceptability is lower among potential users with a low scheme perception. Both the bivariate analysis in Figure 8 and the regression analysis show acceptability to increase with increasing scheme perception. This is true for both parameters, and the parameter with reference to the measure description is a particularly strong predictor. H3 is not rejected.

H4: The acceptability is lower among potential users who perceive the effectiveness of the scheme to be low. This hypothesis is also not rejected, as both bivariate analyses and the regression model show acceptability to increase with increases in expected effective of reporting travel data with the SMiO application.

H5: The acceptability is lower among potential users who perceive the fairness of the scheme to be low. The fairness of the scheme refers to its potential for improving public transport for the individual traveller. There is a clear relation between perceived fairness and acceptability in both bivariate and multivariate analysis. H5 is not rejected.

H6: The acceptability is lower among potential users with a low sense of responsibility. This parameter refers to the respondents' perception of travellers' responsibility for improving public transport. The results show that acceptability increases with an increasing sense of responsibility. H6 is thus not rejected.

5 Discussion

The purpose of this study has been to describe the overall acceptability of the SMiO application and to investigate factors which influence acceptability. As the SMiO application has yet to be launched, this study has not focused on technological acceptance, but rather on measure acceptability.

A survey among 835 respondents shows the acceptability and willingness to use to be high in comparison to other similar studies. Acceptability is higher in men, younger age groups and respondents with elementary education or less. This is in line with previous research presented in chapter 2. Acceptability is also high in respondents who do not hold a travel card, respondents who live more than 1.5 K from the nearest transit stop and respondents who normally travel by bus. The regression analysis show, however, little impact of respondent characteristics on acceptability. This might suggest that the homogeneity of the sample is greater than intra-group variations.

Most prominent in this study is the contribution of explanatory factors. Although problem perception has the strongest coefficient, scheme perception I (*Do you find the description of the measure easy or difficult to understand*) and perceived effectiveness II (*The measure allows my experiences to be taken into account*) make the strongest contributions as they are based on scales from 1 to 5. For one, this suggests that implementation must be accompanied by meticulous information dissemination, both related to its purpose, functioning and expected results.

Additionally, one might expect scheme perception to increase after the SMiO application is launched. Studies show that acceptability tends to increase when influenced actors become more familiar with the measure (Tretvik 2006), and negative attitudes can be overcome if people are informed why the measure can produce superior outcomes (Bies et al. 1993).

This relates directly to the perceived effectiveness of a measure, and it is interesting to note that respondents here tend to expect that their experiences will be accounted for without necessarily improving their public transport services.

The proposed explanatory model for acceptability of the SMiO application only partially accounts for the variance in the sample. This indicates there are other variables with explanatory power that were not included in the study. For one, insecurity related to the specific design and functioning of the application might be of significance. At the time of this survey, it was not possible to provide the respondents with additional information about the user interface of the application and to what degree it would require active involvement on their part. Therein, this study has not allowed for a sufficiently sophisticated measure of consequences to self, which has proved particularly essential in estimating measure acceptability.

Further, certain respondent characteristics which have proved important in previous research are not included in this study. As described in chapter 2, household characteristics such as household composition, income, car access and access to high-tech equipment might influence acceptability.

This is one of few studies which aim at measuring acceptability and recruiting participants to a purely GPS based travel survey. A concern in that respect relates to the resulting sample representing 'public transport travellers' rather than the general population. One could also expect the acceptability of the general population to be dissimilar from the sample of this study, which is dominated by young men with smart phones. As such, this study will not necessarily be sufficient for identifying strategies to increase the overall travel by public transport.

Nonetheless, this study provides a useful foundation for measuring acceptability before as well as acceptance after implementing the SMiO application, and to identify (potential) moderating effects inherent in the travel registrations themselves. As such, this study does not only provide a priori assessment of the SMiO application,

but also serves as a basis for estimating the representativeness of data eventually collected through the application. Thus, by applying acceptability perspectives, studies such as this provide input which shapes the expectations regarding the success of technologically based travel surveys.

References

Bates, J., J. Polak, P. Jones and A. Cook (2001): *The valuation of reliability for personal travel*, Transportation Research Part E: Logistics and Transportation Review, 37 (2-3), pp. 191-229

Baum, S. (1999): *An aggregate level analysis of the socioeconomic correlates of drink driving offenders*, Accident Analysis and Prevention, 31 pp. 213-220

Beirão, G. and J. A. S. Cabral (2007): *Understanding attitudes towards public transport and private car: A qualiative study*, Transport Policy, 14 pp. 478-489

Bies, R. J., T. M. Tripp and M. A. Neale (1993): *Procedural fairness and profit seeking: the perceived legitimacy of market exploitation*, Journal of Behavioral Decision Making, 6 (4), pp. 243-256

Compeau, D. R. and C. A. Higgins (1995): *Computer Self-Efficacy: Development of a Measure and Initial Test*, MIS Quarterly, 19 (2), pp. 189-211

Davis, F. D. (1989): *Perceived usefulness, perceived ease of use, and user acceptance of information technology*, MIS Quarterly, 13 (3), pp. 319-340

Davis, F. D., R. P. Bagozzi and P. R. Warshaw (1992): *Extrinsic and Intrinsic Motivation to Use Computers in the Workplace1*, Journal of Applied Social Psychology, 22 (14), pp. 1111-1132

Engebretsen, Ø. and P. Christiansen (2011): *Urban structure and travel behaviour*, Institute of Transport Economics, TØI Report 1178/2011

Fishbein, M. and I. Ajzen (1975): *Belief, Attitude, Intention and Behavior: An introduction to theory and research*, Addison-Wesley Publishing Company, Reading, MA

Gaunt, M., T. Rye and S. Allen (2007): *Public Acceptability of Road User Charging: The Case of Edinburgh and the 2005 Referendum*, Transport Reviews: A Transnational Transdiciplinary Journal, 27 (1), pp. 85-102

Hawkins, R. and P. R. Stopher (2004): *Collecting Data with GPS: Those who reject, and those who receive*, The Institute of Transport Studies, Working Paper ITS-WP-04-21

Ittner, H., R. Becker and E. Kals (2003): "Willingness to Support Traffic Policy Measures: The Role of Justice", in Schade, J. and B. Schlag (ed.): *Acceptability of Transport Pricing Strategies*, Oxford:Elsevier, pp. 249-266

Kohla, B. and M. Meschik (2013): "Comparing Trip Diaries with GPS Tracking: Results of a Comprehensive Austrian Study ", in Zmud, J., M. Lee-Gosselin, M. Munizaga and J. A. Carrasco (ed.): *Transport Survey Methods: Best Practice for Decision Making*, Bingley, United Kingdom:Emerald Group Publishing Limited, pp. 305-320

König, A. and K. W. Axhausen (2002): *The Reliability of the Transportation System and its Influence on the Choice Behaviour*, paper presented at 2nd Swiss Transport Research Conference, Monte Verità/Ascona, March 20.-22. 2002

Mathison, K., E. Peacock and W. W. Chin (2001): *Extending the Technology Acceptance Model: The Influence of Perceived User Resources*, The DATA BASE for Advances in Information Systems, 32 (3), pp. 86-112

Moore, G. C. and I. Benbasat (1991): *Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation*, Information Systems Research, 2 (3), pp. 192-222

Norwegian Environment Agency, Statistics Norway and Norwegian Forest and Landscape Institute (2014): *Greenhouse Gas Emissions 1990-2012. National Inventory Report*, Norwegian Environment Agency, Report M-137–2014

Paulley, N., R. Balcombe, R. Mackett, H. Titheridge, J. Preston, M. Wardman, J. Shires and P. White (2006): *The demand for public transport: The effects of fares, quality of service, income and car ownership*, Transport Policy, 13 pp. 295-306

Rogers, R. W. (1983): "Cognitive and Pshcyhological Processes in Fear Appeals and Attitude Change: A Revised Theory of Protection Motivation", in Cacioppo, J. T. and R. E. Petty (ed.): *Social Psychophysiology: A Sourcebook*, New York:Guilford Press, pp. 153-176

Roux, S., P. Marchal and J. Armoogum (2009): *Acceptability of the use of new technologies by interviewees in surveys*, paper presented at New Techniques and Technologies for Statistics, Brussels, February 2009

Schade, J. and B. Schlag (2000): *Acceptability of urban transport pricing*, Government Insitute of Economic Research, VATT Research Reports 72

Schade, J. and B. Schlag (2003): *Acceptability of urban transport pricing strategies*, Transportation Research Part F, 6 pp. 45-61

Schade, J. and D. Obst (2009): *Chapter 12. Acceptability*, in the CURACAO Project Deliverable D2: State of the Art Review, funded by the European Commission through the 6th Framework Programme for Development and Research, pp. 152-172

Schlag, B. and U. Teubel (1997): Public acceptability of Transport Pricing, Dresden University of Technology, downloaded from http://vplno1.vkw.tu-dresden.de/psycho/projekte/afford/download/IATSSRP.pdf

Schuitema, G. and L. Steg (2005): *Effects of Revenue Use and Perceived Effectiveness on Acceptability of Transport Pricing Policies*, paper presented at 45th Congress of the European Science Association, Amsterdam

Schwartz, S. (1970): "Moral decision making and behavior", in Macauley, J. and L. Berkolvitz (ed.): *Altruism and helping behavior*, New York:Academic Press, pp.

Statistics Norway (2012): Table 08921: Persons 16 years and older, by sex, age and level of education. Numbers and per cent (C), downloaded from https://www.ssb.no/statistikkbanken/selectvarval/Define.asp?subjectcode=&ProductId=&MainTable=Utdanningsniv04&nvl=&PLanguage=1&nyTmpVar=true&CMSSubjectArea=utdanning&KortNavnWeb=utniv&StatVariant=&checked=true May 26, 2014

Statistics Norway (2014): Table 07459: Population, by sex and one-year age groups. 1 January (M), downloaded from https://www.ssb.no/statistikkbanken/selectvarval/Define.asp?subjectcode=&ProductId=&MainTable=NY3026&nvl=&PLanguage=1&nyTmpVar=true&CMSSubjectArea=befolkning&KortNavnWeb=folkemengde&StatVariant=&checked=true May 26, 2014

Stopher, P., E. Clifford and M. Montes (2008): *Variability of Travel over Multiple Days: Analysis of Three Panel Waves*, Transportation Research Record: Journal of the Transportation Research Board, 2054 (-1), pp. 56-63

Stopher, P. R. (2008): *Collecting and Processing Data from Mobile Tehcnologies*, paper presented at The 8th International Conference on Survey Methods in Tarnsport, Annecy, France May 25-31 2008

Stopher, P. R., C. Prasad, L. Wargelin and J. Minser (2013): "Conducting A GPS-Only Household Travel Survey' ", in Zmud, J., M. Lee-Gosselin, M. Munizaga and J. A. Carrasco (ed.): *Transport Survey Methods: Best Practice for Decision Making*, Bingley, United Kingdom:Emerald Group Publishing Limited, pp. 91-113

Taylor, S. and P. A. Todd (1995): *Understanding Information Technology Usage: A Test of Competing Models*, Information Systems Research, 6 (2), pp. 144-176

Thompson, R. L., C. A. Higgins and J. M. Howell (1991): *Personal Computing: Toward a Conceptual Model of Utilization*, MIS Quarterly, 15 (1), pp. 125-143

Tretvik, T. (2006): *Last year of the toll ring. A survey in Trondheim autumn 2005*, SINTEF, SINTEF Rapport STF A05245 (Norwegian only)

Venkatesh, V. and F. D. Davis (2000): *A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies*, Management Science, 46 (2), pp. 186-204

Venkatesh, V., M. G. Morris, G. B. Davis and F. D. Davis (2003): *User Acceptance of Information Technology: Toward a Unified View*, MIS Quarterly, 27 (3), pp. 425-478

Viegas, J. M. (2001): *Making urban road pricing acceptable and effective: searching for quality and equity in urban mobility*, Transport Policy, 8 pp. 289-294

Vlassenroot, S., K. Brookhuis, V. Marchau and F. Witlox (2010): *Towards defining a unified concept for the acceptability of Intelligent Transport Systems (ITS): A conceptual analysis based on the case of Intelligent Speed Adaptation*, Transportation Research Part F, 13 (3), pp. 164-178

Vlassenroot, S. (2011): *The Acceptability of In-Vehicle Intelligent Speed Assistance (ISA) Systems: From Trial Support to Public Support*,

Vågane, L., I. Brechan and R. Hjorthol (2011): *2009 Norwegian National Travel Survey - key results*, Insitute of Transport Economics, TOI-report 1030/2011

White Paper No. 21 (2011-2012): White Paper on Climate, Ministry of Climate and Environment