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# User Perspectives on Intelligent Transportation Systems

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To all girls on their first day of school

“We don’t see things as they are, we see them as we are.”
– Anaïs Nin (1903–1977)

# Abstract

Intelligent Transportation Systems (ITS), or the advanced use of Information and Communication Technology (ICT) in the transportation context, offers new tools in the continual effort to develop an accessible, safe, and sustainable transportation system. In this thesis, focus is placed on ITS targeting individual use or the end users' transportation experiences, e.g. video surveillance, cashless payments, pedestrian navigation, real-time information, emergency communications, and parking services. For the end user, such services can serve to enhance one's sense of assurance by reducing uncertainty and facilitating planning and dealing with unforeseen circumstances.

However, ITS and the data collection and processing upon which it is built bring their own challenges, as personal data and privacy are fundamentally intertwined. Individuals' data is routinely collected, from which one can infer a broad range of activities and lifestyle choices, and which may have implications over time or in other contexts. Perceptions of technology and data use are contextual; what may be considered acceptable or privacy-invasive in one situation and for one purpose may not hold true for other persons, situations, or purposes. Concerns often focus on aspects of anonymity, lack of knowledge or control, function creep, etc. Furthermore, although individual, end users are affected by policies and technologies guiding data collection and processing, they are rarely involved in decision-making processes, offered realistic alternatives, or able to control their own data.

The aim of this thesis is to investigate end users' perceptions of ITS. As various contexts and factors have proven to influence perception in other research areas, the approach has been to use empirical case studies of different end user groups and ITS systems. Additionally, the case studies vary contexts and contrast potential negative consequences of ITS, such as privacy infringement, with potential positive benefits (which may depend on the circumstances of the particular user group and/or the ITS system), such as increased assurance and independence. Users are surveyed via structured interviews and questionnaires that include items addressing perceptions of benefits/risks, privacy, trust, etc. In investigating ITS from the users' perspective, this research attempts to paint a more holistic view of the issues surrounding the use of ITS in our daily, mobile lives.

The broad-spectrum conclusions are that the respondents, in general, perceive ITS as relatively beneficial, more so on a general, social level, and feel more reassured due to the systems. Privacy concerns are generally not a major barrier for acceptance in the scenarios presented, although respondents do not necessarily express high levels of trust for the data collectors or low levels of risk for data misuse. Results show that perceptions are influenced by a number of factors, such as: the targeted beneficiary; addressing a specific, personal need; perceived personal control of a situation; the actor (data collector); status within the organization; gender and parenthood. There are also indications that end users feel a sense of resignation due to lack of choice, control, or perceived influence. For example, there is no strong interest in discussing technological applications

with companies, government agencies, or elected representatives, nor in searching for information about technological applications irrespective of perceived privacy infringement or acceptability. This may have broader implications, e.g. for decision-making and democratic processes, as perceived lack of influence and perceived lack of interest in participation feed back into each other.

As such, recommendations include informed consent, choice (e.g. opt-in/opt-out), control over one's personal data, ongoing, two-way dialogue between stakeholders (from the beginning of the design process), comprehensive technological assessments, as well as following through on the use of Fair Information Practices/Principles such as limitation of data collection and use, purpose specification, transparency, individual participation, etc. ITS and data collection and processing are not "silver bullets" able solve all problems via "complete and perfect" information. They are additional tools in the toolbox that bring with them their own challenges related to issues such as privacy, lack of choice/control, and technological accessibility. Thus, efforts should be made to address these new challenges, such as technological mechanisms, personal actions and user participation, and proactive organizational policy and public legislation. The research presented in this thesis serves to remind us that a coordinated effort on multiple fronts is vital in addressing users' needs and meeting broader social goals.

**Papers Included in This Thesis:**

**Paper I** – Sochor, J. (2013). Mobility-Enhancing ICT from an Ethical Perspective: The Case of a Navigation System for Visually Impaired Persons. Presented at the 92nd Annual Meeting of the Transportation Research Board (Washington, D.C., January 13–17, 2013). To be revised and submitted summer 2013 for journal publication.

**Paper II** – Sochor, J. (2013). The Reassuring Effects of ICT in Public Transportation: The Perspectives of Older Adults. *Gerontechnology*, submitted for journal publication.

**Paper III** – Sochor, J., Wester M., & Bülow, W. (2012). Privacy in the Eighteen-Wheel Workplace. *Transportation Research Part A: Policy and Practice*, submitted for journal publication, under revision.
Extended from a conference paper by Jana Sochor presented at the 19th World Congress on Intelligent Transport Systems (Vienna, October 22–26, 2012).

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Extended from a conference paper by the same authors presented at the 18th World Congress on Intelligent Transport Systems (Orlando, October 16–20, 2011).

**Paper V** – Sochor, J. & Wester M. (2013). The Impact of Parenthood on Perceptions of Positioning Technologies. *Surveillance & Society*, submitted for journal publication.

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Beri wo, shuy yem wuna mijiy mi.

Jana L. Sochor
Stockholm, May 2013

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# Chapter 1

# Introduction

## 1.1 Overview

A well-functioning transportation system is vital on all social levels, from moving goods and enabling trade to facilitating daily mobility and promoting health and social inclusion. Intelligent Transportation Systems (ITS), through sensors, communications, computing technologies, etc, offer new tools in the continual effort to develop an accessible, safe, and sustainable transportation system. ITS, which can broadly be defined as the advanced use of Information and Communication Technology (ICT) in the transportation context, is built upon data collection, storage, and processing. These, in turn, enable service provision and potential benefits on both the system level and on the individual level, which is the focus of this thesis, via video surveillance, cashless payments, pre- and on-trip planning, navigation, real-time information, emergency communications, etc. For the end users' daily mobility and transportation experiences, such services can serve to enhance one's sense of assurance by reducing uncertainty and facilitating planning and dealing with unforeseen circumstances.

However, these new tools and the data collection and processing upon which they are built bring their own challenges, as data quantity and quality increases, and as information about an individual is fundamentally intertwined with an individual's privacy. While individuals are going about their day, they are routinely tracked in order to collect the sought-after data, which has become a market commodity. From this data, one can infer a broad range of activities and lifestyle choices, which may have implications when used in real time, later in time, and/or in another context. Perceptions of technology and data use are contextual and what may be considered acceptable or privacy-invasive in one situation and for one purpose may not hold true for other persons, situations, or purposes. Concerns over data collection and processing often focus on aspects of anonymity, lack of knowledge about information use, lack of control, function creep, etc. Furthermore, although individual, end users are clearly affected by policies and technologies guiding data collection and processing, they are rarely involved in the decision-making processes, offered realistic alternatives, or able to control their own data.

The aim of this thesis is to investigate end users' perceptions of ITS, particularly ITS targeting individual use and/or the end users' transportation experiences. Users are

surveyed via structured interviews and questionnaires that include items addressing perceptions of benefits/risks, privacy, trust, etc, regarding various technological applications within the transportation context, including video surveillance, phone positioning, radio-frequency identification, pedestrian navigation, and intelligent truck parking. Different user groups are surveyed in order to gain an understanding of the role of demographic factors can play in perceptions of ITS and positioning systems, including disability, age, gender, parenthood, and status within an organization (employee versus employer). Perceptions are also explored for different travel situations, transportation modes, actors (data collectors), levels of personal control over use, etc. In investigating both the potential positive and negative impacts from the users' perspective, this research attempts to paint a more holistic view of the issues surrounding the use of ITS in our daily, mobile lives.

The broad-spectrum conclusions are that the respondents, in general, perceive ITS as relatively beneficial, more so on a general, social level, and feel more reassured due to the systems. Privacy concerns are generally not a major barrier for acceptance in the scenarios presented, although respondents do not necessarily express high levels of trust for the data collectors or low levels of risk for data misuse. Results show that perceptions are influenced by a number of factors, such as: the targeted beneficiary, where systems targeting the general public are perceived more favorably than those targeting individuals; addressing a specific, personal need such as a disability or an extreme situation, which gains favor; perceived personal control, where more vulnerable situations or situations less under the personal control of the individual elicit more favorable responses; the actor (data collector), where public actors are perceived more favorably than private companies; status within the organization, where the employer (company) perceives greater benefits than the employee; gender and parenthood, where men and parents hold more favorable perceptions than do women and non-parents, respectively. There are also indications that end users feel a sense of resignation due to lack of choice, control, or perceived influence, as e.g. there is no strong interest in discussing technological applications with companies, government agencies, or their elected representatives, nor in searching for information about technological applications irrespective of perceived privacy infringement or acceptability. This may have broader implications, e.g. for decision-making and democratic processes, as perceived lack of influence and perceived lack of interest in participation feed back into each other.

As such, recommendations include informed consent, choice (e.g. opt-in/opt-out), control over one's personal data, ongoing, two-way dialogue between stakeholders (from the beginning of the design process), comprehensive technological assessments, and following through on the use of Fair Information Practices/Principles such as limitation of data collection and use, purpose specification, transparency, individual participation, and more. ITS and data collection and processing are not "silver bullets" able solve all problems via "complete and perfect" information. They are additional tools in the toolbox that bring with them their own challenges related to issues such as privacy, lack of choice/control, and technological accessibility. Thus, efforts should be made to address these new challenges, such as technological mechanisms, personal actions and user participation, and proactive organizational policy and public legislation. The research

presented in this thesis serves to remind us that a coordinated effort on multiple fronts is vital in addressing users' needs and meeting broader social goals.

## 1.2 Background

### 1.2.1 ITS Opportunities for End Users

People have many reasons to be mobile, from day-to-day activities involving work, studies, and family life, to maintaining participation in society, health, and quality of life. Indeed, mobility is not only a characteristic of modern social life, but also a precondition for it (Thomsen et al., 2005). The concept of mobility varies greatly between disciplines, from the movement between two points to social mobility between classes to the spread of ideas. One classification divides mobility into four general types of movement: personal, object, virtual (information), and imaginary (media) (Urry, 2000). This thesis focuses on personal mobility, which can be destination-dependent or destination-independent (Metz, 2000), actual or potential (Gudmundsson, 2005; Kaufmann, 2002).

ITS systems and services have great potential to generally enhance individuals' daily, personal mobility and transportation experiences. For example, advancements in positioning and mobile systems allow for increasingly precise and continual measurements of the locations and movements of individuals and objects over time. These tracking and monitoring capabilities facilitate the collection of position, movement and activity data, which enables further development of services and devices, for instance, to provide information for pre- and on-trip planning. Examples of how ITS can enhance and personalize the end users' experience include:

- Information such as maps, journey planners, push notifications, and real-time information;
- Monitoring via sensors and video surveillance (CCTV) systems;
- Positioning that enables navigation, personal alarms, and location-based services;
- Identification to create virtual signs and (geo)tags;
- Authorization via smartcards and RFID tags;
- Communication that is immediate and pervasive.

The increased access to information and communication offered by ITS services (and ICT generally) can serve to reduce perceived risk and uncertainty by imparting a sense of connectedness and control. Information is especially important in unfamiliar locations and situations and can aid all transportation users, from those on the "front line" of transportation (professional drivers) in facilitating their work, to vulnerable social groups, who often need information in order to decide whether to travel or not (Waara, 2013).

In investigating these reassuring aspects of ITS for the individual on the move, the Swedish word "trygghet" is adopted as it encompasses concepts of perceived safety and security as well as connotations of confidence and comfort. As such, the English word "assurance" is used in this thesis rather than some version of "safety" or "security". These concepts, when used in transportation, are often associated with accidents, sabotage, terrorism, or crime, none of which convey the entire meaning of "trygghet".

### 1.2.2 Factors Influencing Assurance While on the Move

When considering personal mobility, one finds a broad range of experiences and barriers such as demographic factors, accessibility, availability, affordability, safety/security concerns, lack of information, etc. Such barriers may in turn act as impediments to public and private services, leisure activities, employment, and education, potentially generating long-term social impacts. ITS offers the chance to mitigate some these concerns and barriers, especially those related to information provision, personalized service, and timely communication and response.

To understand perceptions of transportation and resultant behavior, the *whole journey* point of view is vital, as the most "uncertain" segment in the trip chain can influence the entire trip in terms of mode, path/route, destination, frequency of travel, and even decision of whether or not to travel. What follow are some examples of factors that have been shown to influence perceptions of uncertainty/assurance while mobile and that can be associated with information and communication.[1]

*Information* is essential to travelers, especially about unfamiliar situations or unforeseen circumstances. In Gothenburg, real-time information for buses and trams has been found to increase travelers' sense of assurance (Skoglund, 2012). A lack of maps or service information in public transport reinforces a sense of unfamiliarity and erodes the ability to plan journeys "safely", and timely and accurate information about delays and connections help to decrease passenger anxiety (Stafford and Pettersson, 2004). For vulnerable social groups such as elderly and disabled persons, access to information may be the deciding factor in whether or not to travel (Waara, 2013).

*Familiarity* with an area or activity, including using public transportation or a particular transportation mode, is associated with greater feelings of assurance. The ability to confidently find one's way around is vital to such perceptions (Crime Concern, 1997). ITS offers the possibility to gain a sense of familiarity, e.g. via access to maps and directions.

[1] A multitude of other factors *not* associated with information or communication also influence mobility and one's sense of assurance while traveling and, thus, are not addressed in this thesis. Examples include aspects of the built environment such as accessibility, lighting, station design, landscaping, cleanliness and maintenance, all of which influence both the perceptions and reality of safety and security. For example, indications that the infrastructure or service is not well-managed or controlled can contribute to passengers' anxiety (Stafford and Pettersson, 2004; for the Stockholm case, see Ceccato, 2013).

*Transportation Mode.* A Stockholm survey found that nearly two-thirds of respondents avoided certain modes depending on the circumstances, primarily the subway at night and on the weekends (Alm and Lindberg, 2003). Walking, although involved in many trips, is also perceived as a vulnerable mode; for example, it increases the time of exposure compared to other modes. The need to walk, often alone, can be a deciding factor in whether or not to use public transportation (Stafford and Pettersson, 2004) and fear of crime affects the frequency, route, and time of pedestrian journeys (Stafford et al., 1999). A Swedish study found that walking was the situation that generated the greatest worry and lack of assurance (Alm and Lindberg, 2000). As such, ITS may have a greater positive impact on assurance in certain transportation modes.

The *presence of others* generally increases perceived safety, as the sheer presence of numbers is thought to act as a crime deterrent. Also, the presence of uniformed staff or security helps to create an "atmosphere of control" which people tend to find reassuring (Crime Concern, 1997). A Swedish study found that the attractiveness of public transportation may be more affected by the perceived risk and worry of being bothered, threatened, or attacked than of being seriously injured in accidents (Alm and Lindberg, 2004). ITS may serve to improve assurance in this sense via improved monitoring and timely communication and response.

*Darkness* also significantly affects perceptions while traveling (for the Stockholm case, see Ceccato, 2013). In the United Kingdom, the greatest impact of darkness on safety perceptions is in the subway, where 60% of women and 32% of men said they feel unsafe after dark. Darkness even affects the most preferred mode of transportation – the car (Stafford and Pettersson, 2004). After dark, timely communication and response (via e.g. a personal alarm) become even more important for those who feel unsafe.

ITS may present greater opportunities to improve assurance for certain demographic groups. For example, women, children, and elderly and disabled persons, are often identified in transportation studies of mobility patterns and issues as being relatively more vulnerable. These groups tend to be more dependent on public transportation and report higher levels of perceived unsafety/insecurity in transportation. In the case of elderly and disabled persons, they face more severe consequences if something goes wrong and depend to a greater extent on information in order to be able to travel (e.g. Andersson, 2001; DfT, 2001; SIKA, 2002; Cedersund and Lewin, 2005; Hakamies-Blomqvist, 2005; Knight et al., 2007; Smith et al., 2007; Taylor et al., 2007; Waara, 2013).

The transportation system (and especially public transportation) also concentrates large flows of people and, thus, attracts and generates crime, which, in turn, influences perceptions of transportation-related activities and places (for a general overview and presentation of the Stockholm case, see Ceccato, 2013). A tangential area, fear of crime research, also identifies similar demographic groups as above, such as women, elderly persons, physically vulnerable persons, and persons who hold "risky jobs", among those who are considered more at risk, where women in particular have been found to be willing to restrict their behavior due to fear of crime (see e.g. Hale, 1996, for a review). Thus, ITS may have a greater positive impact on certain demographic groups.

As the above examples show, ITS presents opportunities to mitigate various types of real or perceived uncertainty in transportation, potentially improving the end user's sense of assurance; perhaps more so for specific demographic groups.

### 1.2.3 ITS Challenges and Consequences for End Users

Despite many opportunities for ITS services to enhance one's mobility, assurance, safety, security, etc, the collection and use of position, movement and activity data also has potentially negative consequences, as the use of ICT in transportation and other contexts facilitates easier access to more information for people to use, but about them as well. The data generated and collected by various technologies increasingly fill in the once fragmented picture of one's movements and activities, especially as the personalization of services increases, e.g. via positioning and tracking behavior.

Such tensions within the realm of personal data and technology are not new and will not likely be resolved in the future as society and technology are continually co-evolving. As observed by Glancy (1995), the circular relationship between privacy issues and ITS is complicated by the fact that neither privacy nor ITS is simple or static. In the past, employees in sensitive positions, such as pilots, have been monitored, parents have kept an eye on their children, and companies have tried to understand consumer behavior so as to increase their customer base. What is "new", however, is that ITS (and ICT in general) is facilitating the ubiquity and personalization of data collection and processing, as well as the ease of access and compilation of data from multiple sources. This means that the collection and processing of personal data is becoming a standard rather than an exception – it is done because it can be done more cheaply, easily, and quickly in all aspects of life from public to private, by governments, companies, and individuals, across the globe and for "all" time. It has been argued that this surveillance – "any collection or processing of personal data, whether identifiable or not, for the purposes of influencing or managing those whose data have been garnered" (Lyon, 2001:2) – is an inherent part of the information society and has become a general, institutionalized phenomenon (Lyon, 2001).

What does this mean for the individual/end user? Although an individual may feel anonymous while walking through a crowd or sitting in a vehicle, in reality, they are not anonymous at all from the perspective of the data trails they leave behind them from their mobile phone, GPS, CCTV, RFID, smartcards, and a multitude of other technologies not specifically addressed in this thesis. In practice, an end user cannot go about their day without these technologies (or without using the transportation network), yet they most likely have not been involved the decision-making or development processes, and are usually not offered true alternatives. The technologies often offer increased convenience, at least compared to life without them, which would be more inconvenient, expensive, or difficult, but today's convenience may turn into tomorrow's inconvenience if the data is repurposed, misused, etc. They enable people to help each other (care), but also to check on what others are doing (control). They can make space (feel) safe, facilitating social inclusion, while also enabling social sorting, which promotes exclusion of those perceived as undesirable. It can also be difficult to argue against them, as

surveillance is usually motivated by good intentions and "plausible justifications" such as safety, security, convenience, or efficiency, which fosters compliance (Lyon, 2001). Avoiding the technologies and services addressed in this thesis would essentially mean not participating in society, e.g. avoiding (public) transportation, many public spaces, mobile phones, work duties, etc, which is not realistic. In other words, mobility together with data collection and processing are part of the modern, daily life.

Data and privacy are intertwined at a fundamental level. Privacy in itself is an elusive concept and for the purpose of this thesis, focus is placed on the importance of privacy rather than on nailing down a definition (although it can broadly be considered to be the ability to control one's contact with others, where contact is a general term not limited in time and not only referring to the physical). This aspect of control has been an important element of the concept of privacy (as related to personal data) from the "start" of privacy research, as reflected in Westin's definition from the 1960s: "the claim of individuals, groups, or institutions to determine for themselves when, how, and to what extent information about them is communicated to others" (Westin, 1967:7).

It has been argued that privacy is important, both as an end unto itself, and because it safeguards the more fundamental value of personal autonomy and the ability to lead one's life according to one's own values and self-chosen life plans. As such, privacy, is a key component in freedom and democratic processes (Rössler, 2005). Additionally, privacy enables anonymity, solitude, isolation, reserve, and intimacy, as well as serves the functions of emotional release, and self-evaluation (Pedersen, 1997) and the development of personality and personal relationships (Margulis, 2003). Thus, one can conclude that if privacy or one's values are violated or reinforced in some way by a technology or the consequences of the technology (e.g. surveillance), one's perceptions will be influenced. And this influence is not limited to perceptions of the technology itself, but can spill over into one's perceptions of greater social processes, such as one's (lack of) power in decision-making processes.

Another key aspect of privacy relevant to this thesis is its contextual nature. Nissenbaum (2010) argues that concerns for privacy are concerns about "appropriate flows of information" that are dependent on the social norms within a particular context. Wright et al. (2009) also discuss the need for privacy-related legislation and policies to be improved so as to deal more effectively with context, although a balance will need to be found with maintaining overall coherence.

When discussing privacy, one common notion is "if you have nothing to hide, you have nothing to fear". Due to its prevalence and generality, it is deliberately included in the instrumentation employed in this thesis. However, Solove (2011) claims this argument, although customary, is problematic as it is limited in scope since the concept includes more than concerns about secrecy, illegality, data collection, or even limited disclosure. Among other things, privacy also entails aspects of not having one's data shared with a third party, aggregated with other data, distorted, etc. In other words, a more fundamental problem which the "nothing to hide" argument does not directly capture is exclusion, or individuals' lack of influence and power over how their data is used.

Here, employees are one group that face particular challenges, although our expectations of privacy at work tend to be much lower than in other places, such as our homes (Palm and Hansson, 2005). Palm (2007) argues that increased employee vulnerability is due to four factors: unavoidability, continuity, dependency, and identification. Ball (2010:99) also argues that workplace surveillance benefits the employers far more than it does the employees, "perpetuating wider power asymmetries". Regarding processing of personal data from positioning systems in the workplace, the Swedish Data Inspection Board (DIB, 2011) points out that employees are normally "unable to give the voluntary consent demanded by the Personal Data Act" as they are in a position of dependence relative to their employers. Thus, studying employees' perceptions of ITS used in the workplace is merited.

Following these examples and lines of reasoning, it can be concluded that concerns about privacy are concerns that are not only, and not even mainly, about the disclosure and processing of data. Instead, data is considered private depending on context and control. Loss of privacy, therefore, can be considered part of a larger ethical debate concerning "personal integrity" (which is also the nearest Swedish-language equivalent of the word "privacy") and exclusion.

### 1.2.4 ITS-Related Research on Privacy and User Perceptions

ITS is an emerging and highly applied field with professionals from a variety of backgrounds. Thus, it is not surprising that much of the ITS research (or at least research into movement/vehicles, positioning, etc) as related to privacy and/or user perceptions has tended to focus on particular aspects of the picture.

Some research has focused on more general issues and arguments, such as privacy-related concerns. Rieman (1995) explores ITS' part in intensifying the surveillance society and the potential, subsequent impact of "total visibility" on individual behavior and society as a whole. Glancy (1995) discusses the use of ITS to "manipulate" individuals' transportation choices and behavior; and that road transportation-related ITS enables both "Big Brother" and "Little Brothers", where many private-sector companies can collect personal data (Glancy, 2004).

Other literature explores policy approaches and organizational issues regarding ITS and privacy. Policy approaches generally include legislation as well as recommendations by umbrella organizations, such as ITS America's "Fair Information and Privacy Principles" and the U.S. Federal Trade Commission's "Fair Information Practice Principles" (Cottrill, 2009; Cottrill and Thakuriah, 2011). However, in surveying the privacy policies of "mobility information companies", Cottrill and Thakuriah (2011) find that although privacy policies are now fairly standard, they are generally incomplete, inconsistent, and incomprehensible. They conclude that the privacy policies have been implemented to protect the companies more than the consumers. Fries et al. (2011) surveyed U.S. Departments of Transportation (DOTs) and find that DOTs favor following privacy legislation, but that there is little consensus regarding definitions of privacy-related concepts (e.g. targeted surveillance), let alone any national standards for privacy protection.

Another area of focus is on more technical aspects of privacy and mobility data, such as security, algorithms, anonymization (and re-identification), etc (e.g. Hubaux et al., 2004; Popa et al., 2009; 2011; Elango et al., 2013). Although highly relevant, such technical aspects are not the focus of this thesis, although there is a clear link between how technology is designed and how it impacts privacy. For example, Zimmer (2005) discusses the importance of technical design standards (for vehicle safety communication technologies) and the need to make privacy a part of the technological design process (rather than a retrofit). In this way, designers and developers can preserve the "contextual integrity" of personal information and privacy in the public space.

Few studies have explored user perspectives of ITS and the effects of socio-demographic factors. Although containing a very relevant discussion into the potential effects of ITS and location-based services on women (including privacy aspects), Cottrill and Thakuriah's study (2009) is based on non-responses in a Chicago-area household travel survey, rather than on any direct study of women's perceptions of ITS and privacy. Their study is also self-criticized as inconclusive, partly due to low response rates. Another Chicago-based study by the same authors (Cottrill and Thakuriah, 2012) explores individuals' willingness to trade travel data for e.g. cost, time, safety, and security benefits, etc. They find that consumers are relatively more willing to trade travel data than name and address data. The authors discuss that individuals may not perceive travel data as personally identifying even though it is, which would explain their increased willingness to trade it. The study also finds that privacy preferences and "willingness to trade" are related to personal characteristics and contextual factors such as gender, education, trust for the data collector, and who will have access to the data. Additionally, that there is a gap between perceived privacy risks and protective actions.

In the U.K., a recent study by Cruickshanks and Waterson (2012) explores the potential rejection of future road-based ITS systems as well as their potential restriction of freedom of movement. The study concludes that such fears are justifiable, as 44% state they would stop going to certain places if their whereabouts were always public. Some key groups are identified as most likely to be negatively effected: elderly, poorly educated, female, from an ethnic minority group, and/or not being technologically savvy. The study also finds four distinct groupings of persons with similar privacy concerns. The three groups well-established by Westin's consumer research in the United States – unconcerned, pragmatics, fundamentalists; *or* low, moderate and high concern. (See Kumaraguru and Cranor, 2005, for a survey of Westin's studies.) And a fourth group of "commuters" who show high levels of privacy concern in general, but low levels of privacy concern for ITS. The authors conclude that this is due their spending much of their time traveling, which heightens their appreciation of potential improvements of their travel experiences. An Australian study also finds that a considerable minority perceives a privacy threat affecting their willingness to pay for, in this case, a location-based, pay-as-you-drive insurance scheme (Iqbal and Lim, 2008).

In the context of Sweden, one study has been identified within the context of transport telematics (Lindqvist et al., 2001). This study investigates attitudes about four broadly described scenarios (that sometimes include several contexts) regarding video

surveillance in public transportation, positioning, automatic speed control, and cards for payment and access. They find that the majority are positive towards video surveillance, as it is perceived to potentially reduce crime. Women especially feel it could increase their sense of assurance. The majority are also positive towards automatic speed controls, especially women. The response is mixed in regards to positioning; its use for crime prevention and accident location is perceived favorably, but unfavorably for traffic management. Many view payment cards as a privacy violation, especially when it comes to the possibility of tracking purchases and travel. Overall, respondents feel it very important to use the above systems legally, responsibly, and in an appropriate manner, and to reduce the risk of unauthorized access to and misuse of the information. The thought of registered behavioral and location data creates a sense of insecurity due to uncertainties about how this data is or could be used.

Briefly stepping to the side, e-commerce and the use of online services has been the subject of more research on consumer preferences and behavior related to privacy, risk, trust, and acceptance. Here, one can generally say that increased trust does not necessarily lead to increased acceptance of privacy infringements. Lacohee et al. (2006) argue that individuals make personal risk assessments; not to mean that security risks are not perceived, but that they may be outweighed. Transparent policies, mitigation, and restitution are considered more important than guarantees of security. Kim et al. (2008) discuss how online services are inherently risky and that propensity to trust, privacy and security concerns, company reputation, and information quality effect consumer trust in the website and their willingness to use it.

In studying e-governance, Colesca (2000) finds that privacy concerns negatively affect trust, and that trust, security, and transparency are major issues affecting adoption. Trust in technology and in the organization, perceived quality and usefulness of the e-services, and experience and propensity to trust also affect trust in e-governance. Horst et al. (2007) also conclude that both technological and organizational trust affect perceived usefulness of e-government services, which in turn affects intention to adopt. In other words, high social trust cannot necessarily compensate for low technological trust in terms of increasing acceptance. Although aspects of technological acceptance are also of interest, the author of this thesis refers to the individual, included papers for related discussions of the technologies addressed in this thesis.

ITS' role in the application and use of ICT in our daily, mobile lives is significant and will continue to grow, e.g. with the use personal and embedded devices, Vehicle-to-X communication, etc. As discussed above, privacy, trust, perceived benefits/risks, socio-demographics, experience, policy and more can affect perceptions and willingness to use ITS, e-services, etc. Thus, more and continued research into privacy-related aspects and end users' perceptions of ITS is merited (e.g. Fries et al., 2011; Vautin and Walker, 2011).

### 1.2.5 Research on Factors Influencing Perception

A great many factors, including socio-demographic factors, influence perceptions of risk and benefit and a useful research area in this context is risk perception. However, formal definitions of risk (i.e. probability assessments) have not proven to be very useful or appropriate, and have been highly criticized by e.g. Slovic (2001), who points out that all opinions, even those of experts, are subject to value judgments, context, and "framing" consequences in different but statistically equivalent ways (benefit vs. loss). Also, that many factors affecting risk are not included in theoretical, technical models, including but not limited to voluntariness, perceived benefit, novelty, dread, "tampering with nature", "immoral and unnatural risk", control, and inequity (see e.g. Starr, 1969; Fischhoff et al., 1978; Sjöberg; 2000). Two other important factors to mention are the "risk target", as risk to the general public (or "no target" or to "any one person") is usually rated higher than risk to oneself or one's family (see e.g. Weinstein, 1980; Sjöberg, 2000); in other words, bad things are more likely to happen to other people. Also, trust, which is subject to the "asymmetry principle". Here, distrust has the advantage, as negative, trust-destroying events are more visible, influential, and psychologically believable. Distrust is also self-perpetuating and low trust for those defining and managing risk will also lead to low trust in their risk assessments (Slovic, 1999). In other words, trust is easy to destroy and hard to build. In privacy research, Westin (2003: 438) found that a low degree of trust in institutions handling personal data was correlated to a higher demand for privacy and support for privacy-protective legislation.

Socio-demographic factors are also important in explaining perceptions. Enander's (2005) review of perceptions of security measures found that: women place higher value on risk, worry more, and find the measures less inconvenient and more worthwhile than men; risk awareness increases with age and older people find security measures more worthwhile while younger people find them more inconvenient; parenthood and living with someone both increases risk awareness and leads to the adoption of more security measures; friends and family are considered important sources of information regarding risk; and people with foreign backgrounds are more risk aware but less prone to adopt security measures.

Previous research has also shown the importance of interactions between socio-demographic factors. Studies from the United States have identified a so-called "white male effect" where white males perceive the world as safer and risky activities as more beneficial compared to other groups (e.g. Flynn et al., 1994; Finucane et al., 2000). Olofsson and Rashid (2011) investigated this effect in Sweden and concluded that it should be called the "societal inequality effect" instead. They found that in the relatively more gender equal Swedish society, foreign background, as a mediator of social inequality, etc, had a much greater effect than did gender. No matter the basis of social inequality, these studies clearly illustrate the importance of considering views of minority groups in each society.

One's status within an organization can also affect perspectives. Watkins Allen et al. (2007) found significant differences between employees in managerial versus non-

managerial positions, where more managers thought of surveillance as "beneficial", while more non-managers thought it to be "bad". Oz et al. (1999) also found supervisors to be more accepting of monitoring than non-supervisors, as well as monitored workers more accepting than non-monitored workers, with resistance to monitoring positively related to a perception of its counterproductivity. In Stanton and Weiss' study (2000), employees' reactions to monitoring depended on the perceived implications of the monitoring (i.e. those who believe that monitoring has no influence on their job are not bothered by it and those who believe it does influence their job are bothered by it), which were influenced by the extent and purpose of monitoring.

This earlier research points to several contexts and factors which may also affect perceptions of ITS and which will be considered in this thesis: personal versus general risk, risk target, trust, gender, age, parenthood, status within an organization, etc.

## 1.3 Research Aim and Approach

The aim of this thesis is to investigate end users' perceptions of ITS, particularly ITS targeting individual use and/or the end users' transportation experiences. As various contexts and factors have proven to influence perception (as discussed above under related research), the approach has been to use empirical case studies, with different end user groups and ITS systems, which vary contexts and which contrast potential negative consequences of ITS, such as privacy infringement, with potential positive benefits (which may depend on the circumstances of the particular user group and/or the ITS system), such as increased assurance and independence. How this has been done in each of the four case studies (A–D), results of which are presented in five scientific papers (I–V), is described here:

Case Study A (Paper I) is a structured interview study focusing on the potential effects of a locally developed, tailored pedestrian navigation system (e-Adept, 2013) on visually impaired persons' mobility. This type of user group is relevant to study as technology can be used to compensate for disability as well as create new barriers in terms of accessibility of technology. As a disability can also create particular mobility challenges, a series of questions attempts to paint a picture of the respondents' travel situation, including use of special transportation services versus general public transportation. Then, general attitudes are assessed via questions regarding aspects of transportation and technology, including travel habits/preferences, use and perceptions of ICT, privacy, trust, etc. Scenarios are presented regarding the aforementioned navigation system and phone positioning (i.e. a sub-functionality of the navigation system), each of which is followed by questions regarding perceptions of system effects on assurance, privacy, etc. For the navigation system, additional questions are asked regarding potential changes in mobility and lifestyle, including levels of assurance and frequency of traveling under different circumstances, impact on independence, perception of personal benefit, and interest in purchase. The interview content (in Swedish) can be found in Appendix A.

Case Study B (Paper II) is a questionnaire study investigating the attitudes of older adults (and the effects of gender) towards CCTV, real-time information, and the aforementioned e-Adept pedestrian navigation system. This user group is a natural choice as older adults are the intended secondary market for e-Adept system and as Sweden and many other nations face challenges associated with the aging population. Additionally, gender has also been proven to affect perceptions of both transportation and technology. As the chances of having a disability affecting mobility increase with age, again, a series of questions attempts to establish a picture of the respondents' travel situation, including use of special transportation services versus public transportation. General attitudes are assessed in largely the same way as in Case Study A. However, the scenarios are modified to the above three systems, as it was hypothesized that different levels of personal control over system use would affect perceptions. The subsequent questions again include effects on assurance, privacy, etc, but were extended beyond those in Case Study A to include further questions of effects on assurance in different modes and travel situations, perceptions of personal and social benefit, etc. The questionnaire content (in Swedish) can be found in Appendix B.

Case Study C (Papers III and IV) is a structured interview study with professional Heavy Goods Vehicle (HGV) drivers and road haulage company representatives. This is relevant in several ways: ITS is heavily used in road freight transport and these users are on the "front line" of ITS, workplace privacy studies have yet to focus on the "mobile workplace" or professional drivers, and one's place in an organization has proven to influence perceptions of ICT use in the workplace. Here, background questions focus more on aspects of work. Then, general attitudes are assessed via questions regarding aspects of technology, including use and perceptions of ICT, privacy, trust, etc. This is followed by questions focused on establishing a picture of the workplace situation in terms of ITS, privacy, and assurance, e.g. systems used and perceptions of their benefits for the drivers and companies, general effects of ITS on assurance and privacy, company policies regarding privacy and data collection, processing, and use, trust in the employer, etc. Scenarios in this study are chosen based on proposed "Core European ITS Services", of which two – Intelligent Truck Parking and (Advanced) Incident Warning – are identified for in-depth analysis in relationship to a road-user charging system in Sweden (within a related project affiliated with the author of this thesis). The subsequent questions for each scenario again include effects on assurance, privacy, benefit to driver and company, and, for the company representatives, willingness to pay. The interview content (in Swedish) can be found in Appendices C.1 (drivers) and C.2 (company representatives), which largely mirror each other.

Case Study D (Paper V) is a questionnaire study of the perceptions of the general public on privacy-invasive ICT solutions. It is of course of interest to obtain a nationally representative sample, and this study also enabled the investigation of another socio-demographic factor earlier proven to affect risk perception and use of (security) technology, namely parenthood. This study is based on six technologies, each of which is described in two varying scenarios, contrasting e.g. area of application, level of privacy infringement, actor (data collector), etc. Respondents received two scenarios, although never two for the same technology. The systems chosen for analysis in Paper V are those

three most relevant for today's urban mobility and ITS – CCTV, phone positioning, and RFID. After each scenario, questions covering themes of acceptance, desirability, willingness, trust, benefits, and risks, including privacy-infringement are presented.

Of the five included papers, the author of this thesis is the sole author in two and the principal, main author in the other three. The thesis presents results from four surveys, of which the author of this thesis is primarily responsible for the design of three of the four surveys, fully responsible for the data collection in two of the four surveys, and fully responsible for the survey data analysis presented in the included papers.

## 1.4 Methodology

For Case Studies A and C, the data was collected via individual, structured interviews, a quantitative data collection method in which each respondent receives the same predetermined questions in the same order and the questions often have a limited set of pre-determined responses. This consistency between individual structured interviews enables data aggregation and comparisons across respondents and time periods. Additionally, although contextual effects of question order cannot be completely eliminated, the nature of the structured interview holds the context effects constant across participants.

Structured interviews are employed in these case studies due to two factors. First, a self-administered questionnaire was judged to be a potential deterrent to recruitment as visually impaired persons might find it too demanding or time consuming and as professional drivers might be reluctant to dedicate breaks from driving to such a task. Second, the number of respondents was expected to be limited. Although structured interviews traditionally only allow for minimal responses, the interviewers did allow for respondents to elaborate if they so desired, with additional comments recorded by hand by the interviewer.

In Case Studies B and D, the data was collected via online questionnaires as the number of respondents was expected to be larger. In Case Study B, the question order was consistent with Case Studies A and C due to similar content and in an attempt to hold the context effects constant across these case studies. In Case Study D, the content differed from the other three case studies, as described above, and the questionnaire was administered by TNS SIFO International, who gathered a nationally representative sample.

In Case Study A, the main factor of concern is the respondents' previous experience with the e-Adept navigation system under development in Stockholm and how this might affect their attitudes, particularly their attitudes towards such a navigation system. However, very few significant differences are found between the "experience" and "no experience" groups (discussed in Paper I), which strengthens claims made in this study regarding the generalization of perceptions within this user group as well as the potential impact of the navigation system.

In Case Study B, a concern was the equal treatment of "younger" and "older" older adults' perceptions, however further age stratification did not prove to affect responses, which is discussed in Paper II. In Case Study C, the main factor of interest is employment status (driver or company representative), which does prove to affect some attitudes (although not privacy attitudes); this is discussed primarily in Paper III.

As the data in the case studies is primarily ordinal due to the nature of the ranking questions, the statistical analysis should technically be based on non-parametric methods, e.g. the Mann-Whitney U Test is used to compare differences between two independent groups and the Wilcoxon Signed Rank Test is used to compare differences between two dependent groups. This is the case for Case Studies A–C, especially as the sample sizes for Case Studies A and C were limited. In Case Study D, however, parametrical methods were utilized as is standard practice with large samples, even with ordinal data, e.g. $\chi^2$ tests comparing differences between independent groups for binary questions (yes/no answers), and $t$ tests comparing differences between independent groups for rating scale questions (1–5). Where multiple groups are compared, appropriate tests are employed together with post hoc tests and p-value adjustments. The statistical analyses are per formed using the software package SPSS/PASW Statistics 18.0 or 19.0 for Macintosh. A statistician has been consulted from time to time throughout the analysis process, but any errors are of course the responsibility of the author.

## 1.5 Respondents

Table 1.1 provides an overview of each case study, including a breakdown of the respondents by gender and age. More specific socio-demographics and the recruitment methods are presented in the individual papers.

## 1.6 Broad-Spectrum Results

The author of this thesis has identified several general contexts affecting perceptions of ITS:

- The targeted beneficiary – Targeting the "crowd" and the general public good is perceived relatively more favorably than targeting individuals. Also, ITS' benefits to society are rated more highly than are personal benefits.
- Specific, personal need – A tailored ITS system addressing a specific, personal need, particularly a need affecting one's daily life or an extreme situation, will be more favorably perceived, especially by the targeted user group. The less specific and personal the need, the less the perceived benefit.
- Perceived personal control – ITS is perceived more favorably in more vulnerable situations or situations less under the personal control of the individual; for example, the subway, traveling alone, traveling in an unfamiliar setting, or when the police become involved. Whether real or perceived, ITS can serve to reduce uncertainties and improve one's sense of assurance.

| | **Case Study A** | **Case Study B** | **Case Study C** | **Case Study D** |
|---|---|---|---|---|
| *Data Collection Method* | Structured Interviews | Online Questionnaire | Structured Interviews | Online Questionnaire |
| *Sample* | Convenience | Convenience | Convenience | National |
| *Respondent Group* | Visually impaired adults at least 18 years old | Older adults at least 65 years old | Professional heavy goods vehicle drivers & road haulage company representatives | General public |
| *Number of Respondents* | n = 23 | n = 252 | Drivers: n = 30; Company Reps: n = 20 | n = 1196 total; n = 248-252 per scenario |
| *Gender* | Female = 7<br>Male = 16 | Female = 150<br>Male = 101<br>(this question n = 251) | Female = 4<br>Male = 46 | Female = 600<br>Male = 596 |
| *Age Category or Estimated Age = Response Year - Birth Year* | $\bar{x} = 47.2$<br>range [23, 92] | $\bar{x} = 71.6$<br>range [65, 99] | $\bar{x} = 44.1$<br>range [20, 66] | 16-24: 37<br>25-34: 172<br>35-44: 256<br>45-54: 276<br>55-64: 260<br>65 and older: 195 |
| *ITS* | Pedestrian Navigation<br>Positioning (Phone) | Video Surveillance<br>Real-Time Information<br>Pedestrian Navigation | Incident Warning<br>Adv. Incident Warning<br>Intelligent Truck Parking | Video Surveillance<br>Positioning (Phone)<br>RFID |

Table 1.1: Overview of respondents and technologies per case study

- The actor (data collector) – Systems or services run by or connected to non-commercial actors are more favorably perceived than those associated with commercial actors. However, for those associated with non-commercial actors, this does not mean, in the absolute sense, that trust is high or that the perceived risk of data misuse is low.
- Status in the organization – Employers rate the benefits of ITS more highly than do employees, and both groups rate the benefits to the company as higher than the benefits to the employees (drivers in this case).
- Gender – Females feel relatively less assured when traveling and rate ITS' effects on their assurance more highly than do men. However, men express a greater personal interest in technology. Thus, there is evidence of a gap between those who may gain more from technology and those who are more interested in it.
- Parenthood – Parents hold more favorable attitudes relative to non-parents, as parents perceive higher positive effects and lower negative effects of technological applications. Parenthood can also affect males and females differently, where female non-parents can show relatively heightened risk perception, lower trust in data collectors, and lower acceptance of the system, etc.

Overall, the respondents in these case studies generally perceive the explored ITS systems as relatively beneficial and feel more reassured due to them. Given that effects on assurance and privacy were often rated as positive and neutral, respectively, the hypothesis of a perceived trade-off between assurance and privacy is not supported.

Despite the above, ratings for perceived trust for the actors (data collectors) and risk for data misuse are not particularly favorable in an absolute sense. For example, in interviews, one not uncommon side comment to the question regarding level of trust for data collectors was of the type "I have to trust them" or "I hope I can trust them". Furthermore, the necessity of data collection is consistently rated lower than the usefulness of the same.

Ratings of worry about and offense over use of a system are consistently below or near average. Even the scenario perceived as most privacy-invasive and least acceptable did not elicit particularly unfavorable ratings for these items in the absolute sense, even if they were relatively more unfavorable compared to other scenarios. Thus, perceiving risks does not necessarily lead to end users feeling worried about those risks.

Willingness to discuss with influential parties (relevant authorities, relevant companies, and elected representatives) and willingness to search for information about a technological application are consistently low. This pattern is stable and unrelated to levels of acceptance, trust in the data collectors, or risk for data misuse. Respondents are most willing to discuss with family and friends followed by work colleagues. Thus, trying to bridge a "knowledge gap" between experts and laypeople with more information may not be an effective approach to gain favor with the public. Also, this illustrates that perceiving risks does not necessarily lead to end users taking a proactive role in influencing technological development and use.

Given these results, the author of this thesis submits that end users may feel a sense of resignation due to lack of choice, control, or perceived influence over technological development and use. This may have broader implications, e.g. for decision-making and democratic processes, as perceived lack of influence and perceived lack of interest in participation feed back into each other.

Results more specific to each case study can be found in the individual, included papers, although some points are generalized and discussed below.

## 1.7 Contributions and Discussion

This thesis contributes to the scientific community in several ways. From a more general perspective, it expands on the understanding of user perception, both by reinforcing earlier research and by illustrating the importance of some factors not often considered, e.g. parenthood and its interaction with gender. It also fills a gap in privacy research by considering the situation of employees in the mobile workplace. Additionally, it adds to the research by illustrating the effect of one's organizational role on perceptions, and by addressing the general complexities and continual tensions surrounding technological developments.

Within the area of ITS, first, it treats the emerging field of ITS per se, and second, it helps fill identified gaps in ITS research such as privacy issues and end user perspectives. It also introduces assurance as an expansion on the concepts of perceived safety/security in a way that is of relevance for ITS and end users, that is to include the connotations of confidence and comfort that information provision and mobility enhancement can provide.

The thesis has gathered and analyzed empirical evidence from both the general public and several end user groups identified as having particular stakes in ITS development and transportation/mobility. As transportation and ITS have also traditionally focused on private car drivers, this thesis adds to the ongoing expansion of interest in other user groups and transportation modes, such as professional HGV drivers and public transportation. It also broadens the international perspective by contributing evidence from Sweden.

In considering a range of user groups and ITS systems, this thesis enriches the understanding of how various socio-demographic factors and contexts affect perceptions of ITS. As such, it also identifies some trends in perceptions of ITS use, as well as discusses broader implications (below) for mobility/transportation and ITS/ICT development, and for decisional and democratic processes. This thesis contributes to the discussion of the complex issues surrounding the use of ITS in our daily, mobile lives.

Mobility is not only a characteristic of modern social life, but also a precondition for it (Thomsen et al., 2005). Thus, it is not a typical consumer product where one can choose between competing alternatives, or choose to not use it at all. One can to some extent influence how and when one uses the transportation network, but to not use it at

all is not realistic or generally desirable. In a similar way, the use of certain technologies is fast becoming, if not already, a false choice. Many times, individuals cannot practically refuse the technological solution offered, as trying to perform daily tasks without it is too inconvenient, expensive, or difficult. As such, ITS (or the intersection of transportation and ICT) creates dual layers of dependency for the end user. This places ITS decision-makers in positions of great influence over both individuals and society.

As this thesis shows, technological developments can have conflicting impacts on individuals. While specific ITS systems or services may serve integrity-enhancing functions by improving the possibility to lead an independent and autonomous life, technology development in general does not necessarily result in ethically sound or universally accessible technology. As certain user groups already face mobility challenges (due to e.g. disabilities) in the transportation network, it does not follow the broader social goals of social inclusion and accessibility to potentially add further layers of vulnerability and exclusion due to non-accessible technology or information within that same network. As profit-driven technological advancements tend to not incorporate aspects of inclusiveness from the start, advocacy organizations and governments will keep playing important roles in balancing interests and stepping in to promote e-inclusion, e-accessibility, etc, as they have previously done to promote accessibility in the built environment. And due to this, it will likely remain challenging to develop sustainable business models for maintenance and operation of targeted ITS systems, such as e-Adept in Stockholm.

Although there is a trend toward personalization and influencing the individual's ability to make better-informed travel-related decisions via accurate and real-time information provision, the results indicate greater perceived benefit on the aggregate level (e.g. for the employer/company or for society). Also, that groups identified by e.g. experts, developers, or policy-makers as potentially greater beneficiaries may not perceive themselves as such or be willing to pay due to such factors as lack of interest, desire to maximize profit margins, or even out of principle. This brings into question the possibility of ITS to penetrate the target markets and reach all those who theoretically serve to benefit in order to achieve the envisioned individual and social effects of ITS. As such, business models (and organization/government policies) may need to prioritize market penetration over profit margins via e.g. bundling services, incentives, and subsidizing systems. Also, incorporating end user feedback into development processes and organizational policies will be useful in order to increase system/service relevance for the various end user groups.

Although expectations of ITS are high, there is a general lack of (quality) data regarding the post-deployment impacts of ITS on all levels as well as over time. Technological solutions may also have unforeseen consequences, such as creating new risks or affecting behavior in unexpected ways, and their use changes over time. Gaps between theoretical and real impacts of technologies make it crucial to shift to a more balanced focus across the entire process (both pre- and post-deployment) and dedicate resources to perform proper, systematic assessments. If a technology is not effective in delivering the ex-ante impacts envisioned, then its use should be re-evaluated. Furthermore, assessments should include e.g. sociotechnical aspects as the context of use within an organizational

or legal structure (including policy) also affects the impacts of the technologies.

Gaps in communication between end users and decision-makers should be addressed via ongoing, two-way dialogue and informed consent regarding data collection and processing policies. However, this will not likely be an easy or smooth process, as there appears to be somewhat of a "vicious circle" effect, where end users' perceive a lack of influence, and decision-makers perceive a lack of interest in end user participation. In order to move towards these goals, end users can to be involved both earlier and continually in technological development and decisional processes, they can to become more proactive about participation in such processes (as they clearly have a stake in them), and they can to be offered viable alternatives, such as (opt-in/opt-out), and increased control over the use of their personal data.

Although not directly investigated in this thesis, end users may consider or assume privacy and data protection to be a default, (or a generalized risk more likely to negatively affect someone else). If so, they will not likely take active steps to protect their privacy or be willing to pay for it if it is approached as an extra feature or service. If so, "privacy by design" becomes an even more important tool in protecting privacy and personal data (e.g. RAE, 2007; DIB, 2013).

One may be tempted to ask why governments or organizations should care or bother about involving end users (or employees), shifting control over personal data to the individual, or designing for privacy and data protection. However, Swedish society has chosen to work towards such values as democracy, social inclusion, privacy and personal integrity, rights of workers, consumer protection, etc; thus, end users have a right and an obligation to participate in decision-making processes. One can also argue that as long as mobility and privacy are considered public and individual goods, the ultimate and long-term responsibility of protecting those goods lies with the decision-makers chosen to represent the public and/or having influence over them: primarily government, but also transportation providers, system/service providers, technology developers, etc. For example, government can pass legislation to protect privacy, although this is not enough, as legislation tends to be reactive and lie off the pace of technological development. As Borking (2005) points out: "the law alone cannot protect privacy, as it is not self-executing. Lawyers and technologists should proactively try to solve problems instead of responding to complaints when harm has already been done". Thus, it will be necessary for organizations to also follow through on the use of Fair Information Practices/Principles such as limitation of data collection and use, purpose specification, transparency, individual participation, etc. Additionally, to adopt "privacy by design" throughout the entire lifecycle of a system, which according to the Swedish Data inspection Board will dramatically increase the ability to comply with legislation, improve security, and reduce the risk of unnecessary cost and time-consuming effort in alleviating problems after the fact (DIB, 2013).

ITS (and related data collection and processing) continue to emerge and transportation professionals and technology developers will continue to explore the opportunities they present. However, they are not "silver bullets" able eliminate all inefficiencies and

control all risks via "complete and perfect" information, but are rather new and additional tools to the toolbox in the continual effort to develop an accessible, safe, and sustainable transportation system. As with any tools, they bring with them their own challenges, in this case related to such issues as privacy, lack of choice/control, and technological accessibility. Thus, efforts should be made to address these new challenges, such as technological mechanisms, personal actions and user participation, and proactive organizational policy and public legislation. The research presented in this thesis serves to remind us that a coordinated effort on multiple fronts is vital in addressing users' needs and meeting broader social goals.

## 1.8 Limitations

A limitation in this thesis is related to the stated preference nature of many questions, which could call into question the responses' reliability and limit the strength of claims made about actual, resulting behavior. However, stated preference is the most feasible and used method for studies of user perceptions as revealed preference is based on the ability to track individual behavior or use of a technology, which is not applicable or possible in many of the situations discussed in this thesis.

Case Studies B and D are administered online, which limits the potential respondents to those with internet access. Case Study D is a nationally representative sample, whereas Case Studies A–C are based on convenience samples. As with any sample, one can discuss generalization to a larger group, either within Sweden or internationally. Although these case studies illustrate that context and socio-demographic background do affect perceptions, some general trends can be observed across multiple case studies, e.g. regarding perceptions of ITS as related to assurance, privacy, trust for data collectors, risk for data misuse, etc. Thus, strengthening the generalization of the broad-spectrum results, at least within Sweden. Naturally it is of interest make further comparisons with e.g. other demographic groups/factors, professional groups, countries, etc.

## 1.9 Further Research

Naturally, this thesis has not and could not cover all ITS systems, even those used by or directly affecting different end user groups, e.g. various in-vehicle systems for private car drivers. ITS systems will also continue to develop at a rapid pace and full technological assessments including privacy impacts and end user perceptions are desirable. Also, following up on if the actual benefits and impacts of ITS match those expected, in both type and level, short- and long-term.

Based on experience gained via the case studies, further research of interest includes:

Performing a before-after study to examine the nature of the pedestrian navigation system's actual use and subsequent effects on users' mobility and perceived quality of life. Convenience aspects of the door-to-door, car-based Dial-a-Ride service may prove to be too big a pull to shift users to public transportation due to the use of a navigation

system, particularly when the choice does not hinge on a lack of information. Although considering the aging population, it is highly relevant to further investigate the choice mechanisms between Dial-a-Ride and general public transportation, as the relative tax base for public services will decrease accordingly.

It is also relevant to explore the impacts of other types of disability on perceptions of ITS, in particular considering that ICT solutions that are not fully accessible may create further layers of vulnerability and social exclusion. Here, affordability is another relevant issue and how to create sustainable business models for targeted solutions. Additionally, the situation of cognitively impaired users, for example, presents further challenges from the perspectives of paternalism and voluntary consent. And to better understand how to potentially bridge the apparent gap between those who may gain more from technology and those who are more interested in it.

Comparing different groups of professional drivers (e.g. taxi drivers), investigating international differences between HGV drivers (e.g. across different countries in the European Union, which is attempting to harmonize certain ITS services), and exploring the effects of driver feedback mechanisms and reward structures on privacy and benefit perceptions. Furthermore, it is important to investigate the longitudinal effects of e.g. organizational privacy policies on employee trust and privacy concerns. For the ITP service specifically, further work can quantify the benefit areas for a defined case, assess benefits for HGVs versus private cars, analyze subservices, and extend the empirical analysis to more stakeholder groups.

Furthermore, to develop extensions and specifications of scenarios in order to study effects of function creep and shifts in balance of power between individuals and organizations or authorities. Also, to investigate the potential interactions of resignation, willingness to pay, and the concept of privacy as a public good.

## 1.10 Papers

### 1.10.1 Papers Included in This Thesis

**Paper I** – Sochor, J. (2013). Mobility-Enhancing ICT from an Ethical Perspective: The Case of a Navigation System for Visually Impaired Persons. Presented at the 92nd Annual Meeting of the Transportation Research Board (Washington, D.C., January 13–17, 2013). To be revised and submitted summer 2013 for journal publication.

**Paper II** – Sochor, J. (2013). The Reassuring Effects of ICT in Public Transportation: The Perspectives of Older Adults. *Gerontechnology*, submitted for journal publication.

**Paper III** – Sochor, J., Wester M., & Bülow, W. (2012). Privacy in the Eighteen-Wheel Workplace. *Transportation Research Part A: Policy and Practice*, submitted for journal publication, under revision.
Extended from a conference paper by Jana Sochor presented at the 19th World Congress on Intelligent Transport Systems (Vienna, October 22–26, 2012).

**Paper IV** – Sochor, J. & Mbiydzenyuy, G. (2013). Assessing the Benefits of Intelligent Truck Parking. *International Journal of ITS Research*, DOI 10.1007/s13177-012-0055-3. The final publication is available via `http:\\www.springerlink.com`.
Extended from a conference paper by the same authors presented at the 18th World Congress on Intelligent Transport Systems (Orlando, October 16–20, 2011).

**Paper V** – Sochor, J. & Wester M. (2013). The Impact of Parenthood on Perceptions of Positioning Technologies. *Surveillance & Society*, submitted for journal publication.

### 1.10.2 Other Related Reports and Conference Publications

Sjöström, T., Sochor, J., & Larsson, P. (2011). ITS and Telematic Services—Different Implementation Aspects. Proceedings of the 18th World Congress on Intelligent Transport Systems (Orlando, October 16–20, 2011).

Sochor, J. (2011). *User Acceptance and IT: Privacy Issues and Concerns When Enhancing Mobility*. Project funded by The Swedish Transportation Administration (Trafikverket).

Sjöström, T., Larsson, P., Sochor, J., Udin, C., & Jarlebring I. (2010). *ITS and Telematic Services – Different Implementation Aspects* together with Sweco Infrastructure AB. Project funded by the The Swedish Transportation Administration (Trafikverket).

Sochor, J. & Koutsopoulos, H. (2009). Understanding and enhancing mobility through IT: opportunities and challenges. Proceedings of the 16th World Congress on Intelligent Transport Systems (Stockholm, September 21–25, 2009).

Sochor, J., Koutsopoulos, H., & Dziekan, K. (2008). Urban Mobility and Safety: ITS Technologies And Ethical Issues. Proceedings of the 15th World Congress on Intelligent Transport Systems (New York City, November 16–20, 2008).

This research has also been presented at the World Congress on ITS, the Annual Meeting of the Transportation Research Board, the ITS Sweden National Conference, Transportforum (a Swedish conference), KTH Transport Platform Day, the Swedish STS Association's spring seminar, the 1st ITS UK/Sweden doctoral candidate workshop, KTH seminars (TrafikNet, Safety on the Move), Security Link workshop at LiU, meetings with the Stockholm Traffic Office, Stockholm Public Transport (SL), and Astando AB, and various internal seminars and workshops at KTH and in the Swedish National ITS Postgraduate School. The author appreciates the valuable feedback received from the international and national research community, colleagues, and practitioners.

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