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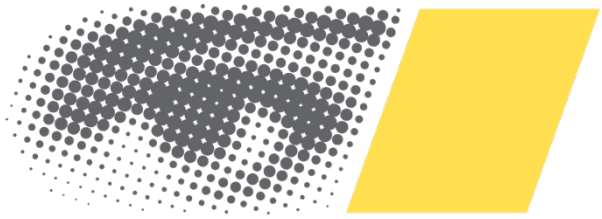

smart eye

# INNOVATION DIFFUSION AT SMART EYE

How can Smart Eye influence the rate of diffusion of their product SAIDMS?

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## Abstract

Road accidents cause millions of deaths and cost around 3% of annual GDP for most countries every year, 80-90% of which are due to human error. European and Chinese authorities have put regulations in place, calling for increased use of advanced monitoring systems which can reduce fatalities and costs associated with road accidents. This paper examines how Smart Eye, a Gothenburg-based eye-tracking company, can facilitate a successful diffusion of their product Smart AI Driver Monitoring System. The study applies a mixed-methods approach, utilizing qualitative interviews with stakeholders along the product's value chain and a quantitative survey directed toward potential end-users of the product to examine important factors for adoption and attitudes toward driver monitoring. The results indicate that concerns regarding personal integrity and costs are the most prominent, whereas concerns regarding availability of service and maintenance as well as product functionality and quality are frequently recurring. Attitudes toward driver monitoring among the quantitative sample of end-users were mainly positive, with the exception of integrity-related concerns. The paper concludes that customer and end-user knowledge and acceptance is important for the diffusion of the product, and that Smart Eye can take proactive steps to increase the rate of diffusion.

## Acknowledgements

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# 1. Introduction

According to the World Health Organization (WHO, 2020), nearly 1.35 million people die in road crashes every year. Between 20 and 50 million people suffer non-fatal injuries each year. Road traffic crashes cost most countries around 3% of their GDP (WHO, 2020). Furthermore, traffic injuries are the leading cause of death for children and young adults aged 5-29 years. Studies have found that over 80-90% of road accidents are due to human error (for example Mosedale et al., 2004; Salmon et. al., 2005; Singh, 2015; Treat et al., 1979).

It is obvious that traffic related deaths and accidents are a major economic cost for most countries, as well as a tragedy in terms of the number of lives lost every year. However, policy makers are addressing the matter, calling for more advanced safety equipment in road vehicles.

On November 8th, 2019, the European Council adopted a regulation to make advanced safety equipment mandatory in all new road vehicles sold on the EU market. By June 2022 all vehicles with autonomous driving capability will require driver availability monitoring systems to get EU type approval. Type approval is the confirmation that production samples of a vehicle design will meet specified performance standards. In addition, by June 2022 all vehicles will need simplified driver drowsiness and attention warning to get EU type approval. By June 2024, all vehicles will require advanced driver distraction warning systems to get EU type approval. Lastly, by June 2026, all new vehicles (old models or new models) will require advanced driver distraction warning. (Official Journal of the European Union, 2019)

It is not only the European Union that is calling for more modern ways of ensuring road safety. In August 2018, the Chinese Ministry of Transport distributed a first draft of a time plan for each Chinese region to roll out with increased driver safety precautions, instructing all localities to urge road transport enterprises to implement and make use of intelligent video surveillance and alarm devices. These call for the following functions, among others: fatigue driving alarms, handheld phone alarms, distraction alarms, alarming if the driver is not in the driving position, smoking alarm and alarming if the hands are taken off the steering wheel. In addition to the system recognizing these risk behaviors, the regulations also require the system to allow for local and remote storage of video and images in conjunction with the

alarm being activated. In contrast to the EU and China, the US authorities have yet to give any official proposals for DMS regulations (see table 1). (Smart Eye, 2020 – Appendix 10.4)

| | **EU type approval** | **Chinese MoT** | **US** |
|---|---|---|---|
| **Vehicle types affected** | • Autonomous driving capability vehicles - driver availability monitoring systems (2022)<br>• All vehicles - simplified driver drowsiness and attention warning system (2022)<br>• All vehicles - advanced driver distraction warning system (2024)<br>• All vehicles (old or new models) - advanced driver distraction warning system (2026) | • Heavy-duty truck operations (total mass 12 tons and above)<br>• Rural bus lines<br>• Tourism charter buses<br>• Dangerous goods road transport vehicles<br>• City buses under investigation<br>• Regional roll out during 2019, deadline unknown | • No official regulatory proposals yet |

*Table 1: DMS-regulations in EU, China & US – Overview*

Similarly to when seat belts became legally required in the 1980s and 1990s in the United States, policy making institutions such as the European Union and the Chinese Ministry of Transport are adopting further regulations to ensure road safety. As such, these regulations entail that Original Equipment Manufacturers (OEMs) of both personal and commercial vehicles aimed at the European market need to concern themselves with ensuring that any new types of vehicle put into production meet the standards put forth in the regulation by the specified dates. Furthermore, by 2026 it entails that all vehicles which are put into production, regardless of whether the type of vehicle is new or old, will need to meet these standards in the European Union. By extension, the new legislation will imply changing market conditions for Tier-1 and Tier-2 suppliers, since some of these suppliers will be the

companies which provide Driver Monitoring Systems to the OEMs, ensuring compliance with EU-regulation.

Although regulations are being put into place and Driver Monitoring Systems being produced, some questions remain: Which DMS-producers will get to supply OEMs to ensure compliance with these regulations? How will such a preventive innovation be diffused among OEMs? Which factors will influence how and by whom the innovation is adopted? How will end-users react to the implementation of such an innovation? This study will aim to answer some of these questions by conducting a case study on the world's leading supplier of eye tracking DMS software.

The supplier in question is Smart Eye, a public Swedish eye tracking company. Smart Eye has achieved most design wins in the automotive sector for Driver Monitoring Systems in the world. In addition, the company has 20 years of experience developing eye tracking systems.

The question is, how can Smart Eye make sure that *their* Driver Monitoring System is adopted by a mass market?

## 1.1 Purpose and Research Question

The purpose of the study is to investigate how Smart Eye can influence the rate of diffusion of their product Smart AI Driver Monitoring System (henceforth referred to as SAIDMS). This will be done by a) studying relevant literature within the research area of, and adjacent research areas to, innovation diffusion b) collecting both qualitative and quantitative data from respondents and samples of populations which the theories of innovation diffusion have found are of importance to the rate of diffusion of a product and c) analyzing this data through the theoretical framework developed in this study.

The aim is to find recommendations for Smart Eye regarding how they can avoid inhibition and facilitate acceleration of the diffusion of their product. The recommendations will be based on theoretical considerations as well as the findings made through data collection and analysis within the scope of this study. Furthermore, the study aims to provide interesting theoretical insights which hopefully will make some contribution to the research field of

innovation diffusion. The overarching research question that this study aims to answer is presented below, together with sub-questions relating to the overarching question which the qualitative and quantitative parts of the study aim to answer, respectively.

- **Overarching research question***:*
  How can Smart Eye influence the rate of diffusion of their product Smart AI Driver Monitoring System?
    - **Qualitative research question:**
      What factors do stakeholders along the SAIDMS value chain consider important for adoption?
    - **Quantitative research questions:**
      What attitudes do future end-users of Driver Monitoring Systems have toward Driver Monitoring?
      Which demographic characteristics and experiences can have an effect on future end users' attitudes toward Driver Monitoring?

## 1.2 Limitations

The scope of this report is to assess how Smart Eye can influence the rate of the diffusion of their product SAIDMS. However, the report will mainly focus on gathering data from Swedish respondents. The main reasons for this are time limitations and lack of data availability. Thus, there is a geographical limitation to the generalizability of this report.

The report will focus on potential direct customers of Smart Eye as adopting organizations of SAIDMS. For this reason, the entire value chain, as well as adoption processes for end users, will not be examined. However, if direct customers and potential direct customers mention factors potentially influencing the rate of diffusion which lie further down the value chain, these factors will be examined and regarded in the final analysis. In a sense, the research conducted will be exploratory, attempting to find influencing factors which the potential adopters mention themselves, rather trying to reject or confirm a hypothesis of influence of a given set of factors. For this reason, some leniency will be taken in the scope of the units and factors examined, potentially expanding the scope if collected data motivates such expansion.

Respondents will be categorized as potential customers, potential end-users, industry organization employees and Smart Eye employees. Potential customers will be examined to understand how Smart Eye can be successful in diffusing SAIDMS. Potential end-users[1] will be studied through quantitative analysis to understand the current attitudes toward Driver Monitoring. Industry organization employees will be interviewed to get a general industry perspective on the diffusion and implementation of DMS.

Lastly, the scope of the report is not to draw conclusions which are generalizable to other geographical areas and markets. However, the qualitative interviews conducted will produce in-depth knowledge about specific factors perceived as important for potential customers in considering adopting a DMS. As such, the market conditions which apply to these potential customers largely apply to other potential customers within the same industries and markets, which could mean that some factors identified could also be found in a replicated study on other potential customers. However, this is for future research to decide.

[1] This quantitative study was conducted between 2019-12-16 and 2019-12-23 as a pilot study for this thesis.

# 2. DMS Industry

In this chapter, I will provide a brief description of Driver Monitoring Systems as a category of products, as well as information about Smart Eye as a company. In addition, SAIDMS as a specific product within the DMS category will be briefly explored, followed by a discussion regarding the DMS market conditions and competitive landscape. The chapter aims to introduce the reader to specific conditions surrounding DMS, in order to facilitate a contextual understanding of the study and its findings.

## 2.1 Driver Monitoring Systems

Driver Monitoring System(s) (henceforth referred to as DMS) are a category of products that are produced to monitor the driver of a vehicle with the purpose of improving road safety and driver safety. Products within this category are of different qualities and functionalities. However, many of them are based on some sort of camera or sensor which monitors the driver and translates facial expressions, behavior, movements and other data input to an assessment of whether or not the driver is fit to operate the vehicle. For example, one common feature is drowsiness detection, which means that the DMS recognizes when the driver is drowsy (i.e. sleepy) and alerts the driver in some fashion (e.g. through a vibration in the seat, an audio alert, or a vibration in the steering wheel). Another common feature is inattention detection, which alerts the driver when he/she is not paying attention to the road for some specified period of time. This is done through monitoring eye movement and head positioning. Dangerous behavior is a less common feature which involves detecting if the driver is using a handheld phone, is eating, is smoking, or other unwanted behavior among, for example, commercial drivers such as truckers or bus drivers. DriverID is a feature which is used to determine the identity of the driver. This feature is, in some cases, required for other features to function, since different people's faces and eyes behave differently. For the system to understand what the driver is doing and whether or not this poses a traffic risk, it sometimes needs to know who is driving to optimize detection after that drivers' specific facial features and eye movement.

Generally, there are a wide range of features in DMS, and features differ from product to product. Different features have different applications and use-cases, and the potential for innovation for some of these products and features is large.

## 2.2 Smart Eye

Smart Eye started with a vision which came from a dream of the father of Smart Eye's current CEO and co-founder, Martin Krantz. Martins father Mats Krantz dreamt that his wife was able to interact with a computer without experiencing the usual shoulder pain brought on by using a mouse and keyboard, by instead being able to control the computer with her eyes. After taking a look at it, Martin concluded that this would be very hard and very possible. He quit his job in the summer of 1999 and started Smart Eye together with his father. (Smart Eye, 2020)

Since then, Smart Eye has focused on developing eye tracking technology that understands, assists and predicts human intentions and actions. An important relationship for Smart Eye has been found in their connection to the automotive industry, which began with SAAB Automobile, which was their very first customer.

Until recently, Smart Eye has had two business areas; Research Instruments (RI for short), which focuses on new insights in aerospace, aviation, psychology, neuroscience, education, as well as medical and clinical research, and Automotive Solutions (AS for short), which offers algorithms and software for the integration with the interior environment of any mass produced vehicle. A large focus within Automotive Solutions has been to enhance safety through DMS, which is a prerequisite on the road toward fully autonomous vehicles, as well as something which will be a legal requirement for *all* new vehicles produced in the EU by 2026 (Official Journal of the European Union, 2019). (Smart Eye, 2020).

Smart Eye recently decided to start a new business area called Applied AI Solutions (AIS for short). This business area focuses on developing a new kind of product which will fill a similar function to the products sold from AS. The main difference is that products sold from AIS will be solutions which involve both hardware and software, instead of only algorithms and software which are the main focus for products from AS. This business area stems from wanting to provide solutions for customers with smaller volumes than those of AS. Developing customized software for a vehicle is costly and doing it for a customer which only wants to sell small volumes of a vehicle (e.g. truck or bus OEMs) can be cost inefficient. For this reason, AIS was started with the intention of producing a standardized aftermarket-product which can be sold directly to OEMs and/or bus/truck operators without having to sell

the product through a tier-1 supplier. Hence, the creation of AIS can be seen as an attempt at downstream vertical integration, since AIS aims to become a tier-1 supplier to OEMs instead of a tier-2 supplier.

## 2.3 The Product (SAIDMS)

The main product which will be sold from AIS is called Smart AI Driver Monitoring System. It is a box which contains one or more infrared cameras, which will be aimed at the driver of a vehicle to gather data and perform functions such as drowsiness detection, inattention detection and dangerous behavior detection. The product will be aimed at customer groups such as bus and truck OEMs, i.e. commercial vehicle manufacturers, personal vehicle OEMs with lower volumes than those acceptable for AS, as well as end-customers such as bus or truck operators and personal vehicle drivers. The aim for AIS is to have as few product or article numbers as possible, meaning that they want to sell as few variations of the product as they can in the spirit of standardization and cost optimization.

Currently, AIS expects to sell five products. Two different electronic boxes, one with low functionality and one with high functionality. In addition, AIS will sell two cameras, one camera which is 6 cm in length and one which is 12 cm. These are the third and fourth products. The fifth product will be an all-in-one solution, meaning that the camera and electronics will be put into one box.

## 2.4 Market Conditions

The global DMS market size was €240 million in 2019 (Smart Eye). The global DMS market is growing rapidly, expecting a compounded annual growth rate of 49%, largely due to change in legislation. By 2020, the size of the market is expected to reach €370 million. By 2025, the market is expected to reach a size of €4 billion.

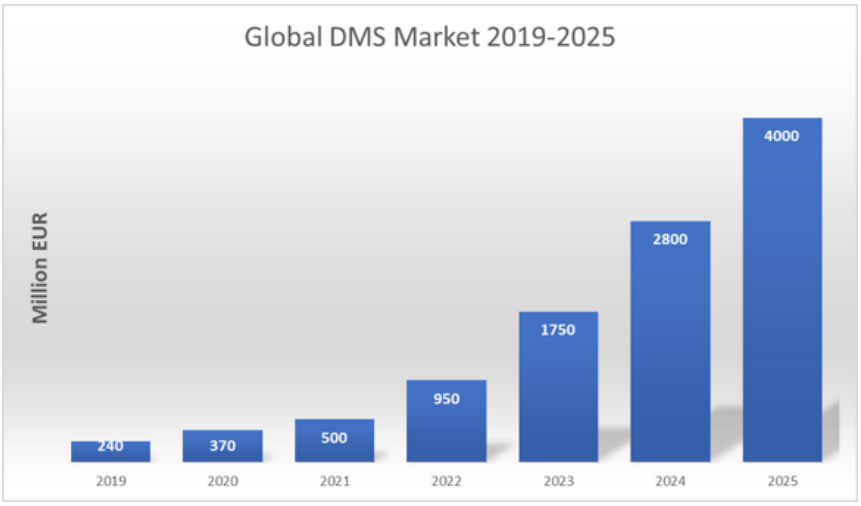

Figure 1 – Global DMS Market, projected growth (source: Smart Eye)

The value chain in the DMS automotive segment consists of tier-2 suppliers, such as Smart Eye, supplying software for DMS systems. Tier-1 suppliers provide hardware and create a complete DMS system, which is then sold to an OEM by securing a design win for a car model. The OEM then sells vehicles with DMS to end-users, which utilize the DMS and its intended benefits. The life cycle of a design win in the DMS automotive industry spans over 20 years with a 14-year production period during which revenue is generated, as the procurement, development, model adaptation etc. occurs during the first 6 years of the life cycle.

The market definition of Smart Eyes previous product is software for DMS, rather than complete DMS systems, since hardware and the complete DMS system is created downstream from Smart Eye in the value chain. Thus, Smart Eye has mainly been an eye tracking company supplying software for DMS systems, which is now diversifying to become a supplier of complete DMS systems. As the value-added increases along the value chain, it is likely that the eye tracking market definition is narrower than the DMS market definition. Smart Eye has the most design wins in the world through in the automotive segment. For these reasons, it is likely that their market share of the market defined as eye tracking software for DMS is larger than their market share as defined by their share of the global DMS market.

To date, Smart Eye has received 81 design wins from 12 different OEMs, meaning that their software will be in 81 different car models. The combined estimated lifetime value from the

current 81 design wins is larger than 2,000 MSEK, i.e. roughly €182 982 000 (€/SEK = 10.93).

## 2.5 Competitive Landscape

Previously, Smart Eye has only focused on selling software for DMS systems, rather than complete systems. With the development of SAIDMS, the company will provide both software and hardware, providing complete systems for OEMs, haulage contractors and bus companies. This means that products sold from AIS, such as SAIDMS, will fall into the market definition of complete DMS systems, rather than only software for such systems.

Smart Eye has four main direct competitors, which are all small-to-medium enterprises: Seeing Machines, located in Australia, EyeSight in Israel, FotoNation in the US and Roadefend from China. Seeing Machines are providing complete DMS, whereas EyeSight and FotoNation are providing DMS software. Roadefend are not using gaze detection, which makes their system less qualified. However, Roadefend does provide complete DMS systems. In addition, some indirect competitors are Visteon and Denso. Denso has a strong partnership with FotoNation focusing on marketing and selling DMS for trucks and buses. Estimated combined annual revenue of these direct competitors is €52 million, which is roughly 21.6% of the global DMS market as of 2019. However, since some of these suppliers do not supply complete DMS systems, it is likely that the concentration of suppliers of software for DMS systems is even higher. (Smart Eye, 2020)

In summary, the DMS market is fairly concentrated, with a few key players making up a large part of the global DMS market. This could change, as legislation opens for more competitors to enter the market. One can conclude, however, that the DMS industry is growing rapidly. The possibility of taking part of the organic market growth in combination with securing more design wins and further shares of the global DMS market indicates that Smart Eye, being a strong player as a software supplier with the most design wins in the world, has a potentially bright future ahead of them.

# 3. Method

In this section of the report, the methodological approach of the study and its implications for the reliability, validity and generalizability of the findings made in the study will be discussed. The qualitative data analyzed consists of 10 semi-structured interviews with potential customers of Smart Eye, industry organization employees and current employees at Smart Eye. The quantitative data analyzed consists of 85 survey responses. The literature review focuses on theories and empirical studies in the field of innovation diffusion, as well as specific research made on preventive innovations and acceptance of Driver Assistance Systems. The analysis consists of regression analyses of the quantitative data and thematic analysis of the qualitative data. At the end of the chapter, I discuss what implications the methodological choices made have for the reliability, validity and generalizability of the findings of the study.

## 3.1 Research Design

The research design of this thesis is a case study design, i.e. a detailed and intensive analysis of a single case (Bryman & Bell, 2007). The case studied is Smart Eye, a Swedish eye tracking company. More specifically, the study is focused on potential actions Smart Eye can take to influence the rate of diffusion of one of their products, Smart AI Driver Monitoring System.

### 3.1.1 Case study

The study aims to examine how a company can influence the rate of diffusion of one of their products. Many diffusion studies are case studies, such as the Iowa Hybrid Corn Diffusion study frequently referred to in Rogers (2003) book Diffusion of Innovations, where the case of analysis is hybrid corn as an innovation, or the adoption of community water systems in Egypt referred to in the same book. If one wants to study how an innovation diffuses, looking at a single innovation and how it diffuses among potential adopters is an intuitive choice.

In this case, the study attempts to describe how a company (Smart Eye) can take action to influence the rate of diffusion of an innovation (SAIDMS). The question is, why a case study, why Smart Eye as a specific case, and why the particular product SAIDMS?

The reason to why a case study is an apt choice to study the diffusion of Driver Monitoring Systems in general or SAIDMS in particular is because it is a fairly new category of product, meaning that products in the category likely differ in functionality and quality among other things. For this reason, choosing a specific product in this category, and a company that produces it, will be helpful in guiding the analysis toward investigating what potential adopters think about functionality that definitely will exist in the product when it is launched. If, on the contrary, a comparative design would be employed, two products with different qualities and functions would be compared, but then the answer to how the diffusion rate can be influenced could be different for the two products and companies. In a few years, when these kinds of products actually have diffused, it would be interesting to compare different DMS products and their diffusion rates. As of now, however, the goal is to investigate what Smart Eye can do to influence the diffusion rate of *their* DMS, SAIDMS, for which a case study is a viable methodological option.

Why Smart Eye? I chose Smart Eye as my case of analysis for two main reasons: a) they are market leading in eye monitoring within the automotive industry and b) they are in the process of trying to reach a mass market. Firstly, this means that they have a product with a relative advantage, which will allow for a focus on perceptions of potential adopters rather than verifying the actual quality of the product. Secondly, it means that they have a goal of diffusing the product to as many customers as possible in the coming years, which aligns Smart Eye's business intentions with my academic intentions, i.e. understanding how they can influence the rate of adoption of SAIDMS.

Lastly, why SAIDMS instead of some other Smart Eye product? Indeed, studying one of Smart Eyes current products could prove interesting, since it would allow investigating success factors contributing to adoption decisions already made among Smart Eyes customers. However, this would prove less helpful for Smart Eye and, in some ways, less academically interesting. Smart Eye already knows why they have been successful with their current customers, and such a thesis would likely focus on Smart Eyes own opinion on its' previous successes in conjunction with the opinions of current customers. Instead, I want to study a phenomenon which is yet to happen, i.e. the diffusion of a *new* product, and how this product can diffuse among a *new* set of customers. This will be done through applying the diffusion model set forth by Rogers (2003), which has made me sensitized to certain facts and pieces of information, such as information relating to product characteristics and

communication channels. I will find answers to questions relating to this model, which I will then interpret through the theoretical diffusion model in order to reach conclusions. Many diffusion studies are made *ex post* in that they study the diffusion of a product after it has already happened (Rogers, 2003). This thesis focuses on studying diffusion *ex ante*, which is a difficult task since it entails attempting to make some sort of predictions of what factors will be important in a diffusion process which has not yet occurred. However, I believe this approach will be interesting as it will provide a temporally unusual approach to a diffusion study. In addition, it will allow for interesting follow-up studies *ex post* which could allow verification or falsification of the findings made in this study.

According to Bryman & Bell (2007), there are a number of different types of cases which can be useful to study for different methodological reasons. Smart Eye and SAIDMS can be considered both a revelatory and a unique case. It is revelatory in the sense that it provides a possibility to analyze a phenomenon which is not easily accessible in terms of timing and availability (there are only so many eye tracking companies currently attempting to reach a mass market with a new product) (Bryman & Bell, 2007). It could also be considered fairly unique, as Smart Eye is a world leading eye tracking company which is currently developing a new product on which I can simultaneously run a diffusion study. This further emphasizes the importance of timing; if the findings of this thesis are found interesting among Smart Eye personnel engaged in the development of SAIDMS, it could help the New Product Development process and potentially enable alterations in communication about, or priorities regarding, the product. This would perhaps not be possible if the study would be conducted at some other point in time

Whether or not Smart Eye and SAIDMS also make out a representative or typical case is yet to be seen, as we do not know currently how standards on DMS will converge or diverge in the future. Hopefully some degree of generalizability will be possible regardless of how typical or atypical Smart Eye and its product is, as some factors (such as potential adopter perceptions of DMS in general) will be generally applicable for all DMS products and not just SAIDMS.

## 3.2 Research Strategy

In this part of the study, I describe how I have chosen to study the research question *How can Smart Eye influence the rate of diffusion of their product SAIDMS*? I discuss the choice of a qualitative and quantitative research method, explaining why they separately provide interesting insights, after which I will address some common arguments against mixed method strategies and discuss why mixed methods is an appropriate choice for studying the chosen phenomenon.

### 3.2.1 Qualitative Method

According to Rogers (2003, p. 593), the innovation diffusion process is driven by subjective evaluations of an innovation:

*Subjective evaluations of an innovation, derived from individuals' personal experiences and perceptions and conveyed by interpersonal networks, drives the diffusion process and thus determines an innovation's rate of adoption. In other words, perceptions count. The individuals' perceptions of the attributes of an innovation, not the attributes as classified objectively by experts or change agents, affect its rate of adoption.*

As such, qualitative methods are more concerned with the point of view of participants rather than the point of view of the researcher. Furthermore, qualitative methods, more than quantitative methods, put emphasis on a contextual understanding of the data, aiming for a deep and rich understanding of respondents' points of view (Bryman & Bell, 2007). As the purpose of this study is to investigate how Smart Eye can influence the rate of diffusion of SAIDMS, and since Rogers (2003) states that the diffusion process is driven by subjective evaluations of an innovation, it seems appropriate to employ a qualitative research method in trying to understand what factors can influence the rate of diffusion of SAIDMS. Thus, the qualitative research effort in this study aims to provide an understanding of the perspective of Smart Eye on what has made them successful so far, and to examine potential customers' concerns and thoughts regarding adoption and implementation of DMS. The research question that the qualitative part of this study sets out to answer is:

*What factors do stakeholders along the SAIDMS value chain consider important for adoption?*

### 3.2.2 Quantitative Method

Notwithstanding the value of qualitative methods in generating a rich and deep understanding of the perspective of respondents, some things are better understood through asking a larger number of respondents and trying to find patterns and measurements in the sample in order to generate a better understanding of general attitudes or indicators (Bryman & Bell, 2007). Viktorová & Šucha (2018) found that Advanced Driver Assistance Systems (ADAS) will not deliver the benefits intended by their designers if they are not known and accepted by the drivers. For this reason, it is important to study the attitudes of end-users of DMS, as DMS is one kind of ADAS. Since there are far more personal and commercial drivers than there are potential direct customers for Smart Eye, and since the attitudes among these drivers can differ depending on a range of variables, a quantitative approach seems appropriate in generating an understanding about end-user attitudes and concerns regarding DMS. The research questions that the quantitative part of this study sets out to answer are:

*What attitudes do future end-users of Driver Monitoring Systems have toward Driver Monitoring?*

*Which demographic characteristics and experiences can have an effect on future end users' attitudes toward Driver Monitoring?*

### 3.2.3 Mixed-Methods Approach

#### 3.2.3.1 Arguments against a Mixed-Methods Approach

According to Bryman & Bell (2007), there are two main arguments against the use of mixed methods research; a) the idea that research methods imply epistemological commitments and b) the idea that qualitative and quantitative research are separate paradigms.

The argument concerned with epistemological commitments mainly states that using a certain research tool or method (e.g. using a questionnaire or an attitude scale) is embedded in commitments to a particular view of the world and to knowing that world. Using a research tool thus implies being involved in "conceptions of the world which allow these instruments to be used for the purposes conceived" (Hughes, 1990: p. 11). The problem with this

argument is that the notion that research methods have fixed epistemological and ontological implications is hard to sustain, as research methods are capable of being put to use for a wide variety of tasks (Bryman & Bell, 2007).

The paradigm-argument sees quantitative and qualitative methods as separate paradigms and argues that these paradigms are incompatible from an epistemological standpoint. Thus, when one combines, for example, a questionnaire with qualitative interviews, one is not really combining methods other than at a superficial level and within a single paradigm, according to this argument (Bryman & Bell, 2007). However, the same problem arises with this argument as arises with the commitment-argument; it rests on assumptions regarding epistemology and the interconnectedness of method which cannot be demonstrated (Bryman & Bell, 2007).

Bryman & Bell (2007) suggest that there are two different versions of the nature of quantitative and qualitative methods: an epistemological version and a technical version. The epistemological version states that quantitative and qualitative methods are grounded in epistemological principles which are incompatible, rendering mixed methods research impossible. The technical version, however, puts emphasis on the strengths of both qualitative and quantitative methods and sees them as compatible. The technical version recognizes that both research strategies are connected with epistemological and ontological assumptions, but those connections are not seen as definite or fixed. Research methods are viewed as autonomous and one research method from one research strategy can thus be employed in the service of another. This study assumes the technical version of the view on the compatibility of quantitative and qualitative research methods.

#### 3.2.3.2 Why mixed methods are employed in this study

From a technical standpoint, then, why is it beneficial to employ a mixed methods approach to answer the research question *How can Smart Eye influence the rate of diffusion of SAIDMS*?

The study aims to increase the understanding of which factors could accelerate or impede the diffusion of a certain product. As such, the value chain through which the product in question will be diffused consists of several potential adopters. Some of these are businesses (e.g.

haulage contractors, bus companies and OEMs), but some of them are individuals (e.g. personal and commercial drivers). Rogers (2003) lifts several examples of diffusion projects which have been failed or discontinued as a result of incompatibility with end-user experiences and values, such as the adoption of community water systems in Egypt, where the end-users had not made the adoption decision themselves but have used the innovation in a way that rendered the innovation useless after a while. In addition, Viktorová & Šucha (2018) found that Advanced Driver Assistance Systems will not deliver the benefits intended by their designers if they are not known and accepted by the drivers. Thus, generating some level of understanding about the attitudes among potential end-users of DMS in general or SAIDMS in particular seems necessary in order to understand what factors concerning end-users could affect the diffusion of SAIDMS. Since quantitative methods are often employed as a means to understand what attitudes a sample of a population have towards something and since such a research method likely has the potential to reach a larger number of respondents in a limited time-frame, it indeed seems appropriate to employ a quantitative approach in discerning end-user attitudes toward DMS.

Other potential adopters, i.e. OEMs and subsequently haulage contractors and bus companies, are organizations. The adoption of SAIDMS among such organizations will likely be a necessary step in order for the product to ever reach commercial end-users, since Smart Eye does not only intend to sell SAIDMS directly to private end-users, and since commercial vehicles are bought and put to use by organizations. For this reason, it is important to also study which factors might affect the rate of diffusion among such organizations. Initially, a survey questionnaire was created and discussed with the supervisor at Smart Eye. As the questions became many, and as many of these questions were formulated in such a way that a free text response was required, it became apparent that the kind of insights that were of interest for the study regarding these organizations were of a qualitative nature. Questions like: “What do you know about Driver Monitoring Systems?”, “How do organizations in the haulage industry communicate about such systems?” and “Which obstacles do you think can impede the implementation of DMS in your industry?” were hard to formulate with a limited range of responses. Ultimately, the inability to ask follow-up questions or to ask the respondent to elaborate on certain points with regard to DMS and diffusion of such systems was enough to convince me to employ a qualitative approach in studying the potential direct purchasers of SAIDMS. Smart Eye and I were interested in deeper insights regarding such

organizations' preferences and concerns with regard to DMS, and a qualitative approach is one of the most viable ways to gain such insights.

By employing both quantitative and qualitative methods in addressing the end-users and potential direct purchasers directly, the study is able to generate findings regarding both direct customers and end-users, which according to previous research (Rogers, 2003; Viktoróva & Šucha, 2018) can both affect the rate of diffusion of an innovation. Furthermore, in the case that the quantitative and qualitative parts of the study generate similar findings, the reliability of those findings will be increased as they will have been triangulated. Triangulation in mixed-methods research means that "(...) the results of an investigation employing a method associated with one research strategy are cross-checked against the results of using a method associated with the other research strategy." (Bryman & Bell, 2007).

## 3.3 Data collection

In this section the collection of qualitative and quantitative data will be described and discussed critically. The qualitative data was collected between 2019-12-09 and 2020-03-18 through interviews with Smart Eye employees and phone interviews with potential customers for the AIS business area. The quantitative data was collected between 2019-12-16 and 2019-12-23 through a survey with a number of questions related to driver monitoring.

### 3.3.1 Qualitative Data Collection

#### 3.3.1.1 Sampling of interview respondents

The sampling of interview respondents in the qualitative part of this study has largely been done through snowball sampling, i.e. asking respondents to suggest other potential interviewees (Bryman & Bell, 2007). After some discussions and one interview with my supervisor at Smart Eye, which were largely based on factors deemed important for innovation diffusion by Rogers (2003), this person recommended profiles which could give insights regarding Smart Eyes previous successes and current customers.

Potential customers were identified by looking up some of the largest haulage and bus companies in Sweden from Business Retriever. After asking to speak with someone in charge of driver safety or working environment issues (as recommended by my company supervisor), I came in contact with someone responsible for driver safety, or similar functions, at four different companies. After interviewing these respondents, I asked if they knew of anyone else they thought I ought to interview with regard to the subjects that had been discussed during the interview. This way, I came in contact with three employees at two different industry organizations, which enabled me to get a more general industry perspective on DMS adoption and implementation, rather than just the perspective of individual companies.

#### 3.3.1.2 Interview Methodology

The qualitative interviews conducted in this study were of a semi-structured character, i.e. based on an interview guide but with a loose and flexible interview structure (Bryman & Bell, 2007). Respondents were allowed to go out on tangents and to reflect on what they found were most important in relation to questions asked. The interview guides were shared with respondents one day in advance in the case of Smart Eye employees, enabling them to prepare themselves for the interviews. Interviews were recorded and notes were taken in conjunction with the interviews, enabling me to highlight moments of the interview which were particularly interesting. In 10.2 of the appendices is one example of an interview guide used for one of the Smart Eye employees. Questions were focused on, for example, Smart Eyes previous success factors, the plan for AIS as a new business area and future sales projections. The questions were constructed in an open-ended manner, so that respondents would not be directed toward a certain kind of answer. Moreover, questions were created with a foothold in the innovation diffusion-framework, attempting to find out how Smart Eye has communicated about their product and why customers have chosen Smart Eye as a supplier. Not all questions were asked during every interview, as the conversation focused on the aspects of the interview guide deemed to be most important in the eyes of the respondent.

With potential customers, interviews were conducted over the telephone for two main reasons: convenience (as most of the potential customers interviewed do not reside in Gothenburg) and Covid-19 (as trying to meet the interview respondents during a global pandemic would probably be considered unethical and careless). The reason that the

interviews with Smart Eye employees were conducted in person is that these were conducted prior to Covid-19 being classified a pandemic. Furthermore, interview guides were not shared with respondents in the potential customer-category. However, my perception is that this did not affect the quality of the interviews, as respondents were somewhat aware of what DMS are and what their opinions were on the subject of DMS. Thus, they could easily discuss top-of-mind issues related to DMS, which provided interesting data. The qualitative interviews were conducted in Swedish, as this is the native language of the respondents in this study. They were then translated to English. In 10.3 of the appendices is an example of an interview guide used for interviewing potential customers. Questions were focused on gauging the company's level of adoption and knowledge about DMS, what potential obstacles to DMS implementation the respondent could identify for the company and how a supplier could aid the company in overcoming such obstacles. The questions were constructed with a foothold in the innovation diffusion theory, so that the interviews would generate valuable information about what companies consider important in order to facilitate DMS-adoption, both relating to the product itself and other factors such as workers union resistance and employee dissatisfaction. The general principle was to ask open questions, which allowed the respondents to choose what they focused their response on.

Since the interviews with potential customers were semi-structured, not all of the questions above were asked in every interview. In some cases, a respondent would take off on a tangent, describing what he or she thought was most important on the subject we discussed. This was encouraged and helped generate interesting insights into what potential adopters of DMS are most concerned with. The interview guide for industry organization employees were of a similar character but concerned more with the industry perspective on the same subjects.

#### 3.3.1.3 Discussion: Interviews with potential customers

Overall, the interviews with potential customers (and industry organization employees) provided me with interesting and rich qualitative data. However, some points with regard to how the data was collected should be stressed, as it could have had an effect on the final outcome of the study. Firstly, all seven interviews with potential customers and industry organization employees were conducted over the phone. As Bryman & Bell (2007) state, it is not possible to observe body language or other physical responses to a question. Body

language could be important, as it could help understanding the full extent of the response given to a certain question, including confusion or discomfort. However, with regard to the kinds of questions asked and purposes of the interviews conducted, my assessment is that it is not likely that this has largely affected the quality of the data used in this study.

Perhaps the most important implication of conducting phone interviews is that I was not able to record the interviews, and thus had to take extensive notes in order to keep track of all that was said. There are a number of advantages to recording and transcribing interviews (for example, it allows for more thorough examination of what people say and helps correct natural limitations of our memories) (Bryman & Bell, 2007). Furthermore, as I had to focus on taking extensive notes while simultaneously asking questions, the quality of some interviews might have been affected compared to a scenario where I could have recorded and transcribed the interviews, or a scenario where I could have had someone assist me in taking notes, allowing me to focus only on asking questions. Although this might have affected the quality of some interviews, it has likely only had a marginal impact on the outcome of the interviews, as I was still able to conduct fruitful and extensive interviews with all of the respondents. In retrospect, conducting interviews live and recording them rather than conducting phone interviews and taking notes would have been a methodologically better option. This was, as previously mentioned, not possible, since most respondents lived far from Gothenburg and since Covid-19 had been classified as a global pandemic at the time of interviews with potential customers.

#### 3.3.1.4 Discussion: Interviews with Smart Eye employees

Interviews conducted with Smart Eye employees were conducted at Smart Eyes office in Gothenburg. They were recorded and transcribed, and interview guides were distributed at least one day in advance. Perhaps the largest methodological issue in some of these interviews is that parts of some interviews resulted in discussions not directly related to the research question. This is a consequence of semi-structured interviews allowing for a large degree of leeway in how respondents respond to a question (Bryman & Bell, 2007). Some discussions were very interesting, but not directly related to the research question.

With a more structured approach and theoretically grounded questions, discussions could have been more focused on innovation diffusion and the research question of this study.

However, no interview was entirely omitted because of this issue. In addition, some of these irrelevant tangents were necessary to arrive at points and discussions which later turned out to be relevant to the research questions, which makes me question if a more structured approach would have helped generate more interesting and relevant data or if it would only have helped to avoid the discussions which were not directly relevant.

## 3.3.2 Quantitative Data Collection

### 3.3.2.1 Sampling of survey respondents

The population that the quantitative part of the study aims to investigate is potential end-users of Driver Monitoring Systems. Thus, the sampling frame consisted of anyone currently drives a car or will drive a car circa 5 years from now. The quantitative data collection aimed at a high representativeness between the sample and the population across different demographic variables such as age, income, gender and education level. The survey was sent out through digital channels, as this allowed the most respondents in a limited period of time. When I noticed that the sample was skewed toward a younger group of respondents, I asked some older acquaintances to distribute the survey to their networks. This way, the sample became more representative in terms of age and income.

A more accurate sampling could have been made by sending the survey to respondents belonging to a more defined population (i.e. Swedish citizens or professional drivers in a specific country). The quantitative study aimed at reaching as many respondents as possible in a short time, which raised the probability of sampling errors, i.e. differences between the sample and the population it aims to represent. However, the sample seems to be fairly evenly distributed in terms of income level, educational level, age and gender. As we can see in table 2, there is a slight over-representation of male respondents in the sample.

| | **Male** | **Female** | **Total** |
|---|---|---|---|
| **Gender** | 62.35%<br>53<br>respondents | 37.65%<br>32<br>respondents | 100%<br>85<br>respondents |

*Table 2 – Distribution of male and female respondents*

Among the respondents, 36.14 percent have completed an undergraduate university education. 31.33 percent have completed a graduate level degree. Thus, a majority of respondents have completed a university education. A minority (28.92 percent) have only completed a high school diploma. One respondent is a PhD, and two respondents have not completed high school. 62.35 percent of respondents were male, and 37.65 percent of respondents were female (see table 2).

| | **Has not completed high school** | **High school** | **B.Sc** | **M.Sc** | **PhD** | **Total** |
|---|---|---|---|---|---|---|
| **Educational level** | 2.41%<br>2 respondents | 28.92%<br>24 respondents | 36.14%<br>30 respondents | 31.33%<br>26 respondents | 1.20%<br>1 respondent | 100%<br>85 respondents |

*Table 3 – Distribution of respondent education level*

In table 4, we can see that there is a fairly even distribution of income among the respondents. 18.82 percent state that their yearly income is between 0 and 180 000 SEK in one year. 9.41 percent make between 180 000 SEK and 360 000 SEK. 32.94 percent state that they make between 360 000 SEK and 540 000 SEK. 14.12 percent state that their yearly income is between 540 000 SEK and 720 000 SEK, and 24.71 percent have a yearly income of above 720 000 SEK. Thus, a majority of respondents make more than 360 000 SEK a year.

| | **0 SEK – 180 000 SEK** | **180 000 SEK – 360 000 SEK** | **360 000 SEK – 540 000 SEK** | **540 000 SEK – 720 000 SEK** | **>720 000 SEK** | **Total** |
|---|---|---|---|---|---|---|
| **Yearly income** | 18.82%<br>16 respondents | 9.41%<br>8 respondents | 32.94%<br>28 respondents | 14.12%<br>12 respondents | 24.71%<br>21 respondents | 100%<br>85 respondents |

*Table 4 – Income level distribution among respondents*

People in the ages between 18-29 and above 50 years old make up a majority of the sample. 23.5% of respondents were between 18-29 years, and 38.8% of the sample were between 50-

59 years old. The categories 30-39 years and 40-49 years consisted of 9.4%, respectively. Lastly, 18.8% of the sample were above 60 years old.

| | **18-29 years** | **30-39 years** | **40-49 years** | **50-59 years** | **>60 years** | **Total** |
|---|---|---|---|---|---|---|
| **Age** | 23.5%<br>20<br>respondents | 9.4%<br>8 respondents | 9.4%<br>8 respondents | 38.8%<br>33<br>respondents | 18.8%<br>16<br>respondents | 100%<br>85<br>respondents |

*Table 5 – Age distribution among respondents*

Most of the respondents have more than 20 years of work experience. However, a fairly large part of the respondents had between 1-10 years of work experience (25.9%). The smallest part of the sample was the category of people with 11-20 years in the work force.

| | **1-10 years** | **11-20** | **21-30 years** | **31-40 years** | **>40 years** | **Total** |
|---|---|---|---|---|---|---|
| **Years in work force** | 25.9%<br>22<br>respondents | 9.4%<br>8 respondents | 18.8%<br>16<br>respondents | 32.9%<br>28<br>respondents | 11.8%<br>10<br>respondents | 100%<br>85<br>respondents |

*Table 6 – Respondent years in workforce*

#### 3.3.4.2 Questionnaire

The questionnaire was aimed at gauging respondent's attitudes toward DMS in terms of how one would feel about driving a car with a DMS, whether or not one would feel safer with a DMS in their car and what potential concerns the respondent had with regard to DMS. Questions were constructed with the help of the head of AIS and the product owner of SAIDMS. In addition, one developer had the chance to have a look at the questionnaire and to provide some input, as information from the surveys could potentially prove useful from a product development standpoint. The question regarding which concerns respondents might have was constructed in an open way with only a free text response possible, ensuring that the respondents were not influenced to answer among a specific set of potential concerns.

The question “Does your work require you to drive a car” could have been formulated more clearly. From its current formulation, it is not clear if the respondent has to drive a car *to* their work or *while* working, which makes it impossible to separate respondents with a long way to work from professional drivers (e.g. truckers, taxi drivers). Furthermore, the questions asking respondents how much safer they would feel if their own car or every car had a DMS almost implies that one ought to feel safer. A better way to phrase the questions would be “How much safer or how much less safe would you feel if your car/every car had a DMS. Lastly, there is a risk that the respondents’ opinion on Driver Monitoring was anchored by the information in the questionnaire if they had no previous knowledge. The questionnaire can be found in the appendix.

## 3.4 Data Analysis

### 3.4.1 Qualitative Data Analysis

The question which the qualitative data analysis aims to answer is:

*What factors do stakeholders along the SAIDMS value chain consider important for adoption?*

After interviews had been conducted, the notes and transcriptions were translated from Swedish to English. In doing this, I also made sure to make the qualitative data clearer and cleaner by writing out full formulations and explanations, either from recordings or from memory. While doing this, I was careful not to change the meaning or interpret what had been said, in order to make sure that the revised notes and transcriptions were still as valid as the original statements made in the interviews.

After having produced a clean, clear mass of text, I plotted down key findings from each interview which all relate in some way or another to a) the theoretical framework developed in this study and b) the research question. This was the first-order coding of the thematic analysis (Bryman & Bell, 2007). Anything that was mentioned which could have a potential effect on the rate of diffusion of SAIDMS, either theoretically or intuitively, were included in these key findings. This created more concise results from each interview which all connected back to the purpose of the study.

After plotting down key findings from each interview, these key findings were connected back to the theoretical framework of the study and to the quantitative findings of the study. This second order coding (Bryman & Bell, 2007) helped contextualize the findings and relate them to what previous researchers have found is important in innovation diffusion. It also allowed me to see similarities in findings made in the quantitative and qualitative research efforts, respectively. As such, key findings were usually found to be either potential accelerators for or potential obstacles to the diffusion process. For example, the relative advantage of Smart Eyes software was found to be a potential accelerator, whereas the lack of acceptance on behalf of the workers union was found to be a potential obstacle.

### 3.4.2 Quantitative Data Analysis

The questions which the quantitative data analysis aims to answer are:

*What attitudes do future end-users of Driver Monitoring Systems have toward Driver Monitoring?*

*Which demographic characteristics and experiences can have an effect on future end users' attitudes toward Driver Monitoring?*

The analysis was done through linear regression in SPSS Statistics. Linear regression is useful when one wants to examine the relationship between two or more variables. More specifically, it is useful to predict the value of a variable based on the value of another value. Since the second quantitative research question aims at understanding which demographic characteristics and experiences can have an effect on attitudes toward DMS, and since I was comfortable with using linear regression, it felt as a suitable analysis tool for providing an answer to the second quantitative research question.

Independent variables were introduced stepwise. The order in which the variables are introduced can affect what is observed. For example, if the variables Gender or Traffic Accident had been introduced as the two last variables, we would not know how the effect of Gender would change throughout the addition of more control variables. The purpose of the quantitative part of this study is exploratory in the sense that the study has no clear hypothesis. The study merely wants to explore what effects some demographic characteristics

and experiences could have on attitudes toward Driver Monitoring; thus, the order of variable introduction was in many ways random. As such, the most interesting model in all three regression tables is Model 9, which shows the effects and significances when all variables are included. If the effect of a variable or its significance does not stand in Model 9, I have chosen not to consider that variable as having an effect on the dependent variable notwithstanding significant effects in earlier models in the same regression table.

In models which try to explain human behavior or attitudes, there are a lot of factors at play. Therefore, running regressions on survey data which try to include relevant parameters to explain the intended dependent variable, there is always a risk of receiving a low Adjusted R-square value, which is the case in some of the models in this study. In spite of this, the effects that are significant can be considered significant regardless of the model's explanatory power. A low Adjusted R-square could be caused by many things, such as a low sample size and a failure to include more relevant variables. Increasing the sample size and adding other independent variables could help increase the percentage of the variance in the dependent variable explained by the model. Naturally, if more relevant variables would be added, this could affect the relation between the variables which are now included. However, trying to decipher which of the effects and correlations are spurious or suppressed is beyond the scope of this study. As stated before, the purpose of these analyses is to understand which effects *can* help predict attitudes toward Driver Monitoring. In future research, trying to isolate the effects of some of these variables and to explain which of them are actually a root cause of the variation in the dependent variable could be a relevant scope.

The stability of the results in this report, i.e. whether or not the respondents would reply similarly at a later point in time, has not been tested through running the survey two times. It is possible that respondents' attitudes could change over time. Since stability can change over time, so can the reliability of the findings in this report. The quantitative part of the study set out to measure attitudes toward Driver Monitoring and has done so by measuring the percentage of respondents who are positive toward driving a car with a Driver Monitoring System, whether or not Driver Monitoring would make them feel safer, whether they would want to buy a car with a DMS, as well as what demographic characteristics and experiences can have an effect on said attitudes. Therefore, the validity of the measurements, i.e. whether or not the analyses measure what they intend to measure, is high.

# 4. Theoretical Framework

In order to understand how Smart Eye can influence the rate of diffusion of SAIDMS, we need to know what factors previous research has found can influence the rate of diffusion of an innovation. The following chapter aims to introduce some fundamental principles of the theory of innovation diffusion, which is employed as a theoretical point of departure in the study. Furthermore, the chapter provides a critical discussion of factors that can accelerate or inhibit the diffusion of an innovation. The chapter then focuses on research about preventive innovations, which is the category of innovations which SAIDMS belongs to. The chapter also addresses specific research made on diffusion of innovations among organizations (i.e. B2B diffusion of innovations), considering that Smart Eye currently is a tier-2 supplier and thus sells its' products primarily to other companies. Lastly, previous studies made on products similar to Driver Monitoring Systems (e.g. Advanced Driver Assistance Systems) are reviewed, in order to better understand what knowledge already exists regarding similar products.

## 4.1 Innovation

An innovation is an object, a practice or an idea which is perceived as new by a unit of adoption, e.g. an individual or an organization. Whether or not the idea is objectively new in terms of when the innovation came to be matters less for the definition of an innovation than how the idea is seen by the potential adopter. As such, it is the perceived newness of an idea that determines if it is an innovation (Rogers, 2003). Many innovations are technological, and we often use the terms "innovation" and "technology" interchangeably. According to Rogers (2003, p. 98), a technology is a "design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome". Usually, a technology involves both a hardware aspect, which consists of the material and/or tool that embodies the technology, and a software aspect, which consists of an information base for the tool (Rogers, 2003). One such example is the laptop on which this thesis is being written, consisting of transistors, electrical connections, semiconductors, circuits and protective material for these components (hardware), as well as all the applications, coded commands and instructions which enable the laptop to be used for certain tasks (software). Innovations, as opposed to inventions, require an area of application and hence commercial success

(Granstrand, 2010, p. 30). By all standards, SAIDMS matches the criteria of an innovation. However, whether the product reaches commercial success or not remains to be seen.

## 4.2 Innovation Diffusion

Innovation diffusion is defined as the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 2003). Innovation diffusion has been studied within various research fields, such as anthropology, political science, geography, economics and marketing. This study focuses on the diffusion of a product and will thus consider the elements and applications of innovation diffusion as a theoretical concept which are beneficial to understanding how one can accelerate the diffusion of a commercial product. The innovation diffusion theory is applied as a theoretical point of departure of the study, sensitizing me to certain kinds of information which according to the theory could be of relevance for the rate of diffusion. The elements of innovation diffusion which Rogers (2003) mention are the innovation itself, time, communication channels and the social system.

### 4.2.1 The Innovation Itself

Rogers (2003) mention five attributes of an innovation which affect the likelihood of adoption. These are:

- *Relative advantage:*
  How advantageous is the innovation with regard to earlier solutions or products which aim to fill a similar function? The higher the relative advantage, the higher the likelihood of adoption (Rogers, 2003). This attribute has been criticized (Mahajan, 1990; Tornatzky, 1982) on the basis of relative advantage becoming a collection-bin of product properties which do not fall into other attribute categories. Relative advantage is generally harder to communicate for preventive innovations than for non-preventive innovations (Rogers, 2003).
- *Observability:*
  How observable is the innovation? This attribute encapsulates both the observability of the innovation itself and the observability of the desired results of the innovation

(Chismar, 2003). For preventive innovations, observability is generally lower (Rogers, 2003) than for non-preventive innovations.

- *Trialability:*

  To what extent can the innovation be tried and experimented with in order to reduce potential uncertainties which an adopter can experience. By trying out the innovation, a potential adopter can form an opinion about the innovation and see if it fits with the needs of that particular adopter (Rogers, 2003).

- *Compatibility*:

  How compatible is the innovation with the adopters' previous experiences, values and norms. An innovation with a high degree of compatibility is more likely to be adopted (Rogers, 2003).

- *Complexity*:

  If the innovation is perceived as difficult to understand and use, the likelihood of adoption decreases (Rogers, 2003). Thus, complexity in the eyes of the adopter should be reduced in order to facilitate adoption.

### 4.2.2 Time

Rogers (2003) states that time is connected to three aspects of innovation diffusion, namely: the innovation adoption process which describes the stages of the process that leads to adoption or rejection; the categories of adopters, which describes different kinds of adopters and their typical characteristics; the rate of diffusion, meaning the time required for adopters from initial knowledge of an innovation until the adoption decision has been made (Rogers, 2003).

#### 4.2.2.1 Innovation Adoption Process

The course of events occurring from when an adopter gains knowledge of an innovation until the decision to adopt or reject the innovation has been made is called the innovation adoption process. The stages in this process are; the knowledge stage, persuasion stage, decision stage, implementation stage and confirmation stage (Rogers, 2003) (see figure 2). However, the innovation adoption process could differ depending on the characteristics of the innovation which is being diffused, as shown by Weinstein & Sandman (2002) who developed the

Precaution Adoption Process Model, a stage theory which seeks to explain the adoption of new health-protective behaviors. For practical purposes, Rogers (2003) traditional innovation adoption process will be described below and applied critically in the analysis of empirical data found in this study.

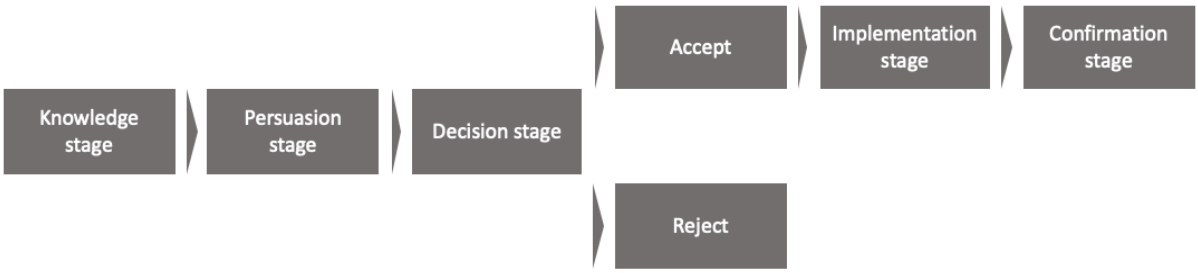


Figure 2: Innovation adoption process, based on Rogers (2003)

#### 4.2.2.1.1 Knowledge stage

In order for a potential adopter to be interested in an innovation and make the decision to adopt, a prerequisite is that the potential adopter has knowledge of the product, which is why the knowledge stage is the initial stage of the innovation adoption process. The knowledge kan arise in two different ways; either the adopter actively searches for information regarding the innovation, or the potential adopter passively comes across the information. In the case of active searching for information, the person in question likely has a need and searches for some solution to satisfy this need. In the case of passive information collection, the potential adopter most likely has been subject to some sort of message, e.g. through a commercial message, advertisement or telemarketing call, which has made the potential adopter aware of the innovation. (Rogers, 2003)

Rogers (2003) specifies three different types of knowledge in the knowledge stage. Awareness-knowledge, i.e. knowledge that an innovation exists, how-to knowledge, i.e. information necessary to use an innovation properly, what quantities of the innovation to obtain, etc., and principles-knowledge, i.e. information dealing with functioning principles underlying how the innovation works.

#### 4.2.2.1.2 Persuasion stage

After gaining knowledge about an innovation, the potential adopter enters the second stage of the adoption process, namely the persuasion stage. In this stage, the potential adopter forms an opinion regarding the innovation by considering pros and cons of the innovation in question. Information is actively sought in order to form an opinion and reduce uncertainty regarding the investment an adoption would entail, more so from individuals in the potential adopters' immediate proximity and less so from mass media channels. Thus, interpersonal channels matter more in the persuasion stage than in the knowledge stage, whereas mass media channels matter more in the knowledge stage (more on this in chapter 3.2.4). Lastly, a positive or negative opinion in the persuasion stage does not necessarily lead to adoption or rejection in the decision stage. (Rogers, 2003)

#### 4.2.2.1.3 Decision stage

The third stage in the innovation adoption process is the decision stage. In this stage, the potential adopters decide to adopt or reject the innovation. If uncertainty remains in this stage, which is more likely in the case of preventive innovations, it can be reduced through the potential adopter trying out the innovation on a partial basis. A small-scale trial can often be an important part of the decision to adopt. If the potential adopter decides to reject the innovation it can either be done actively, i.e. through considering and perhaps trying the innovation before deciding to reject it, or passively, i.e. through never really considering the use of the innovation. (Rogers, 2003)

#### 4.2.2.1.4 Implementation stage

When a potential adopter has decided to adopt an innovation, the adopter enters the implementation stage. This stage occurs when the adopter puts the innovation to use. Some uncertainty still exists for the typical adopter at the implementation stage, even though the adoption decision has already been made. Questions regarding where the innovation can be acquired, how it is used and what problems might arise and how to solve them are common in this stage. Thus, active information seeking takes place in the implementation stage in order to further reduce uncertainty. The implementation stage ends when the new idea becomes a regular part of the adopters ongoing operations. (Rogers, 2003)

Implementation problems are usually more complicated in organizational settings rather than when the adopter is an individual. In the case of organizations, implementers might be

different people than the decision makers. In addition, structures within the organization could resist implementation of new ideas which threaten the old way of doing things. (Rogers, 2003)

#### 4.2.2.1.5 Confirmation stage

In this stage of the innovation adoption process, the adopter seeks reinforcement for an innovation-decision that already has been made. This decision may however be reversed if the adopter is exposed to exposed to conflicting messages about it. (Rogers, 2003)

### 4.2.2.2 Categories of adopters

Consumers are generally heterogenous in their willingness to subject themselves to risk, which is reflected in their purchasing behavior. Some individuals can invest in something despite large uncertainty, whereas others require proven results and prior adoption before they purchase or adopt something new. Based on risk-propensity in conjunction with investment, which can be defined as the length of the adoption process, adopters can be divided into five categories where typical behaviors can be identified. These categories are; innovators, early adopters, early majority, late majority and laggards (see figure 3). (Rogers, 2003)

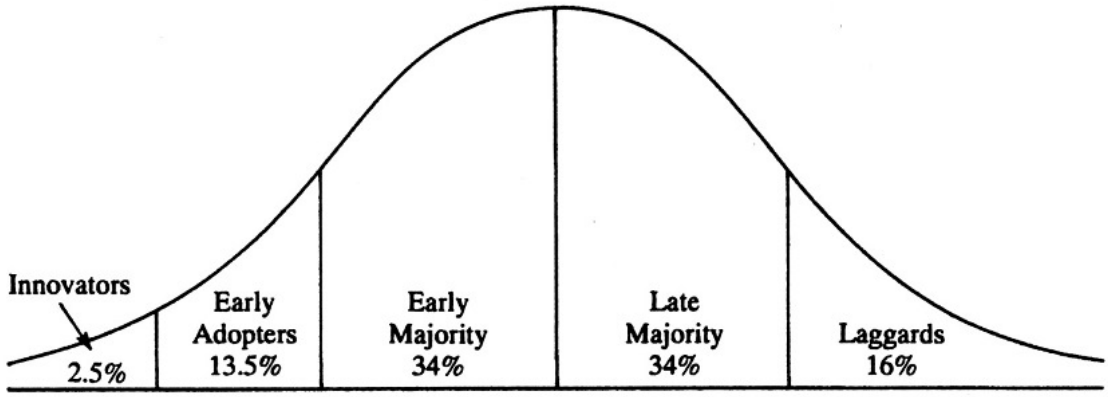


Figure 3: The innovation adoption curve, from Rogers (2003)

#### 4.2.2.2.1 Innovators

The first adopters of an innovation are referred to as innovators. These are categorized as the first 2.5 percent of the population and possess an ability to deal with uncertainties regarding the innovation. This is because innovators generally have a genuine interest for innovations

coupled with a financially good position. For this reason, innovators can bear the risk of investing in an innovation under high degrees of uncertainty, as their financial situation allows for some failure-rate in new investments. Furthermore, innovators are the adopters which bring an innovation into a social system and thus allows it to be adopted by other categories of adopters. However, since innovators are risk-prone and not generally viewed as opinion leaders, the large majority of the population tends to not take heed of the recommendations of innovators. (Rogers, 2003)

#### 4.2.2.2.2 Early adopters

The second earliest group are referred to as just that; early adopters. They consist of 13.5 percent of the population and often possess an influence on the opinion of the rest of the population. Less risk-prone adopters ask the advice of early adopters, which is why this group of adopters has an important role for the continued diffusion of an innovation. (Rogers, 2003)

#### 4.2.2.2.3 Early majority

The third category of adopters are the early majority, which are the remaining 34 percent of the first half of the adopting population. This group is the largest and do not possess the same opinion leadership as early adopters. Adopters in this category are deliberate and take longer to persuade compared to the earlier categories and function as a link between the more risk prone and the more skeptical categories of adopters. (Rogers, 2003)

#### 4.2.2.2.4 Late majority

The fourth category is the late majority, which also consists of 34 percent of the total population. This group of adopters is skeptical and choose to adopt an innovation only when the pressure from friends and direct links in their own social system becomes large. They have a cautious approach to new products and require a small degree of risk and uncertainty in order to make the decision to adopt. Thus, it takes even longer for this category to adopt than the early majority. (Rogers, 2003)

#### 4.2.2.2.5 Laggards

The last group to adopt an innovation are referred to as laggards. This name is not meant to be a slur or demeaning, since it can be completely rational for laggards to wait before adopting an innovation. Laggards consist of the last 16 percent of adopters and are risk averse. They generally have a weak standing in their social system, have a financial situation which does not allow for risky investments, and their social system mainly consists of other individuals with similar attitudes toward innovations. (Rogers, 2003)

### 4.2.2.3 Rate of diffusion

The rate of diffusion is the relative speed with which an innovation is adopted by members of a social system. Generally the rate of adoption changes with time, since there are relatively few individuals who adopt in the beginning of a diffusion process. As time passes, the innovation is spread to more members of the social system, to the point where it reaches a critical mass. At this point, the diffusion process becomes self-sustaining and will continue without the need for further stimulation from a change agent. On the contrary, when this point is reached, the diffusion of an innovation would be very hard to stop.

As the number of individuals who have not adopted the innovation decreases, the rate of adoption slows down and the diffusion process comes to an end. Plotting the diffusion process, it takes the form of an S-shaped curve (see figure 4). The slope of this curve differs between innovations since product lifecycles differ, but the S-shaped curve has been found to hold true for many different kinds of innovations. (Rogers, 2003)

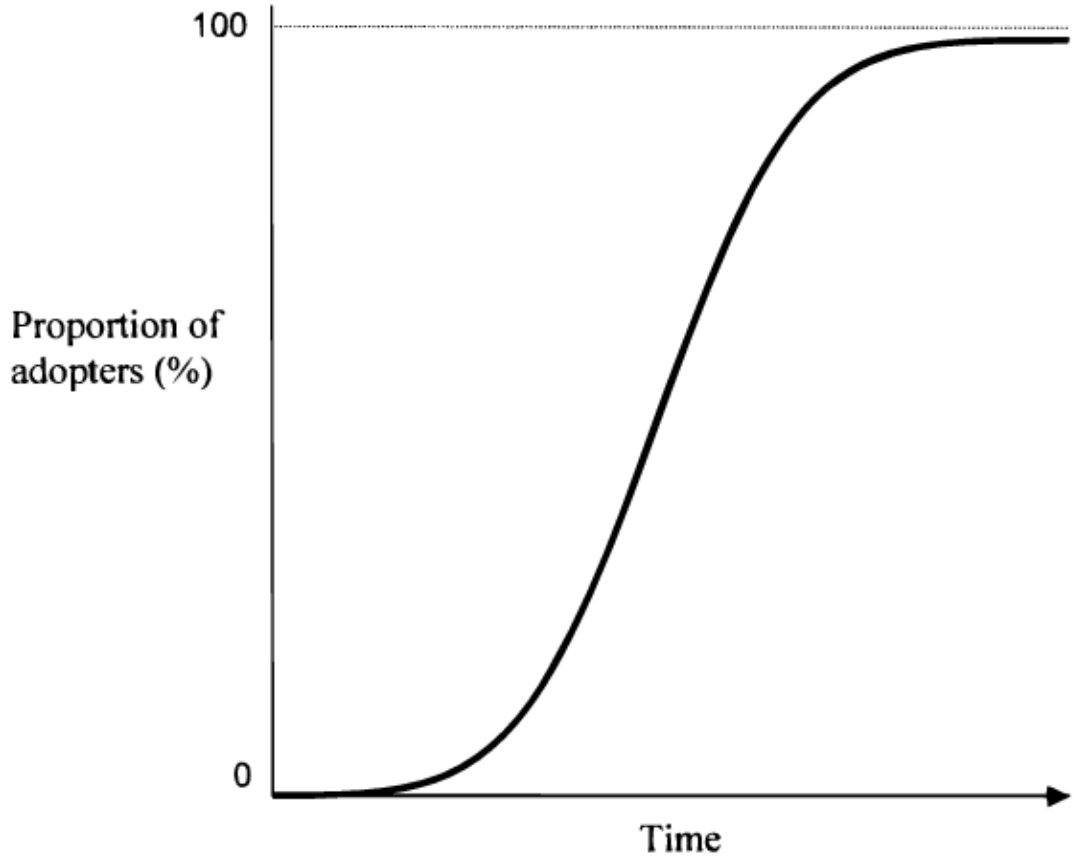

Figure 4: The S-shaped diffusion curve, from Jangsuk (2001)

### 4.2.3 Social System

The social system is a set of interrelated units, which could be individuals, organizations, informal groups, and/or subsystems, that are engaged in joint problem solving or trying to accomplish a common goal. For example, a social system in an innovation study could be families in a village, consumers in the UK or the managers at a firm. (Rogers, 2003)

### 4.2.4 Communication Channels

Rogers (2003) defines communication channels as interpersonal channels or mass media channels, as well as localite or cosmopolite channels. Interpersonal channels are channels which involve a high degree of personal communication between individuals, whereas mass media channels are channels which reach a large audience but with a low degree of personal engagement and interaction (Rogers, 2003). Furthermore, cosmopolite channels are channels which reach outside of one's own social system, whereas localite channels are channels which are centered around one's own social system.

### 4.2.5 Criticisms against diffusion research

According to Rogers (2003), there are four major shortcomings of diffusion research. These are the pro-innovation bias, the individual-blame bias, the recall problem and the issue of equality in the diffusion of innovations:

- The pro-innovation bias points out that most diffusion studies imply that the innovation studied *ought to* be diffused and adopted by members of a social system, that this diffusion *should* occur rapidly, and that the innovation *should not* be re-invented or rejected.

- The individual-blame bias implies that diffusion research tends to hold individuals responsible for their problems, rather than assuming a system-blame approach where the system in which an innovation is diffused or not diffused is the main focus point.

- The recall problem states that *ex-post* diffusion studies can be methodologically problematic if they are conducting a long time after the diffusion has occurred. Naturally, the memory of how and why a diffusion occurred will fade over time.

- Lastly, the issue of equality in innovation diffusion means that socioeconomic differences among members in a social system often increase rather than decrease as a result of the diffusion of innovations.

## 4.3 Preventive Innovations

SAIDMS is a product which aims to prevent road accidents and traffic related fatalities and injuries. Since the product aims to prevent something unwanted to happen, it can be referred to as a preventive innovation (Rogers, 2003).

Preventive innovations are innovations that are created to prevent some future, unwanted event from occuring (Rogers, 2003). According to Rogers (2003), the relative advantage of preventive innovations is difficult to demonstrate because the advantages occur at some future and unknown time, and may in fact not occur at all. For this reason, the relative advantages of preventive innovations are highly uncertain.

What makes an individual adopt a preventive innovation? Cegielski, Hall & Overstreet (2013) performed a meta-analysis of 63 studies (n = 31,158) to examine predictors of the intent to adopt preventive innovations. The authors found that a positive attitude toward preventive innovations is positively related to the intent to adopt a preventive innovation. Furthermore, Cegielski *et al.* (2013) state that subjective norms, i.e. the feeling of social pressure to perform or not perform a certain behavior, are positively related to the intent to adopt a preventive innovation. Perceived behavioral control and self efficacy are also positively related to the intent to adopt a preventive innovation (Cegielski *et al.*, 2013). Perceived behavioral control is defined as a person's belief about the difficulty or ease of performing a given action, and self-efficacy is defined as one's belief in one's ability to perform a certain task or achieve a certain outcome (Cegielski *et al.,* 2013).

How preventive innovations specifically diffuse among companies and other organizations is a less explored area of research. Furthermore, SAIDMS as a preventive innovation is not aimed at preventing some future, unwanted event from occuring to the OEMs per se, but instead aimed at preventing traffic accidents from occuring to the end users of the product the OEMs produce, i.e. vehicles. However, the end user perception of the relative advantage of SAIDMS as a preventive innovation is potentially important for its diffusion. For this reason, it is necessary to be aware that the relative advantage of SAIDMS, as with any preventive innovation, is highly uncertain. One way to reduce this uncertainty could potentially be to make visible the direct results in accident reduction stemming from the implementation of SAIDMS in some setting, i.e. increase the observability of the results of the innovation.

## 4.4 Innovation Diffusion and Organizations

The purpose of SAIDMS is to increase safety on the roads, reducing deaths and injuries as well as economic costs arising from road accidents. However, the product is to be sold to OEMs, haulage contractors and bus companies and, potentially, personal drivers. For this reason, and since Rogers (2003) only briefly discusses organizations as the unit of adoption, it is important to understand what previous research has found regarding innovation diffusion among organizations, i.e. B2B diffusion of innovations.

With regard to what determines organizational innovation adoption, Frambach & Schillewaert (2002) discussed the main findings on organizational adoption and integrated them into a framework, outlining determinants of organizational innovation adoption. According to this summary of organizational adoption research, variables with a positive reported relationship on the probability of organizational innovation adoption are: Relative or economic advantage of the innovation, as well as its compatibility, trialability and observability; size and innovativeness of the adopting organization; the interconnectedness of the organizations social network; targeting/communication and risk reduction by supplier; network externalities. Determinants with a reported negative relationship with the probability of organizational innovation adoption are the perceived complexity and uncertainty of the innovation. Organizational structure and competitive environment are two determinants which can vary in their relationship with the probability of adoption. (Frambach & Schillewaert, 2002)

Frambach & Schillewaert (2002) also discuss which determinants have a positive relationship with the continued use of an innovation, rather than just the initial adoption decision. The continued use depends more on individual innovation acceptance, which in turn is affected by a range of factors. These factors are organizational facilitators/internal marketing (training, social persuasion, organizational support), personal characteristics (demographics, tenure, product experience, personal values), attitude towards innovation (beliefs, affects), personal dispositional innovativeness, and social usage (network externalities, peer usage). The conceptual framework states that internal marketing can generate a more positive attitude towards innovation, whereas personal characteristics determine one's personal dispositional innovativeness. Both personal dispositional innovativeness and one’s attitude towards innovation create individual acceptance. Lastly, social usage, i.e. peer usage and/or network externalities, can affect both one’s attitude towards innovation and one’s individual acceptance of an innovation. (Frambach & Schillewaert, 2002)

Focusing more on specific products and factors contributing to their success, Cooper & Kleinschmidt (1987) examined 203 new products and what determined their commercial success. Among the studied products were automotive components, chemicals, computer

equipment, electronics and telecommunications, metal working equipment, and aviation instruments. As such, the study included products sold to other organizations, rather than only B2C products. The strongest success factors found were 1: product advantage (i.e. the product: offering unique features for the customer, being of higher quality, reducing customer costs, being innovative, being superior to competing products in the eyes of the customer, and solving a problem for the customer), 2: proficiency of predevelopment activities (i.e. undertaking a set of up-front activities, such as initial screening, preliminary technical assessment, detailed market studies or marketing research, as well as financial analysis), and 3: protocol (i.e. having a clear definition, prior to the product development stage, of target markets, customer needs, wants and preferences, product concepts and product specifications/requirements). Other, relatively strong success factors, were: proficiency of technological activities, proficiency of market-related activities, technological synergy, market potential and marketing synergy. Success is earned, the authors argue, and is not an ad hoc result of situational or environmental influences. (Cooper & Kleinschmidt, 1987)

Another study focusing on inter-organizational innovation adoption, but focusing specifically on the vehicle manufacturing industry, was made by Ashwin W. Joshi (2017). Joshi (2017) examined what actions suppliers can take to foster innovation implementation. More specifically, the study focused on OEM implementation of supplier-developed component innovations. Joshi (2017) found some actions which play an important part in fostering innovation implementation among OEMs, namely: acquiring knowledge about OEMs, providing installation support, securing endorsements from innovative OEMs, investing specific assets in the OEM relationship, and investing in the continual innovation of the component. In addition, Joshi (2017) found that functional advantage (i.e. the component enhancing product performance in downstream markets) is a theoretical mechanism which mediates the impact of knowledge acquisition and installation support. Furthermore, reputational advantage (i.e. the component enhancing OEM reputation in downstream markets) is a theoretical mechanism which mediates the impact of innovative OEM endorsement. Lastly, relational advantage (i.e. the component extending the expected time period over which the economic gains arising from the enhancements are realized) is a theoretical mechanism that mediates the impact of specific asset investment and supplier innovativeness on innovation implementation. (Joshi, 2017)

Another way in which organizational innovation adoption has been problematized is through researching what ability organizations actually have to adopt an innovation. Paul Attewell (1992) emphasized know-how and organizational learning as potential barriers to innovation adoption for organizations. Attewell (1992) proposed that firms delay in-house adoption of complex technology until sufficient know-how to implement and operate the technology successfully is obtained. In addition, Attewell (1992) found that new institutions come to be in response to knowledge barriers. These institutions progressively lower these barriers and make it simpler for firms to use and adopt technology without extensive expertise. Consultants, service bureaus and simplification of the technology are some examples of such institutions. Diffusions speeds up as knowledge barriers are lowered, and the technology moves from being obtained as a costly and complex external service to becoming more standardized and easier-to-use, managed completely in-house (Attewell, 1992).

Inter-organizational innovation adoption is one interesting sub-genre of diffusion research, but another field of research arising as a consequence of employing organizations as the units of adoption is intra-organizational innovation adoption. Investigating how factors emphasized by the traditional perspective on innovation diffusion (Rogers 2003) apply within an organization, Cool et al. (1997) found that different regimes govern the rate of diffusion of an innovation *within* an organization before and after critical mass is reached. According to their findings, supply-related factors are dominant before critical mass is reached, and demand factors are more important after critical mass is reached (Cool et al., 1997). As such, Cool et. al (1997) recommends to not apply the traditional diffusion indiscriminately within organizations, since they found supply-related factors are more important for accelerating the rate of diffusion prior to reaching critical mass. Supply related factors were defined as factors influencing the costs of introducing the innovation, whereas demand factors were defined as factors that influenced the rewards from introducing the innovation (Cool et al., 1997). The notion that supply factors are equally as important as demand factors was also emphasized by Brown (1981) in his influential critique of the traditional diffusion model. While SAIDMS primarily aims at inter-organizational diffusion, the potential importance of supply-related factors is important to bear in mind when studying which factors could influence the rate of diffusion of SAIDMS.

To summarize:

- Supply factors, i.e. factors influencing the cost of introducing an innovation, can be as important as demand factors (Cool et al., 1997; Brown, 1981) in intra- and inter-organizational innovation diffusion.
- Product advantage, proficiency of predevelopment activities and protocol are the strongest factors contributing to the commercial success of new products (Cooper & Kleinschmidt, 1987).
- The innovation itself, the size, innovativeness and interconnectedness of adopting organizations, targeting/communication, supplier risk reduction and network externalities are variables which increase the probability of organizational innovation adoption (Frambach & Schillewaert, 2002). A complex and uncertain innovation, however, can lower the probability of organizational adoption (Frambach & Schillewaert, 2002).
- Supplier actions which can foster innovation implementation among OEMs are: acquiring knowledge about OEMs, providing installation support, securing endorsements from innovative OEMs, investing specific assets in the OEM relationship and investing in the continual innovation of a component (Joshi, 2017). Furthermore, if the component has a functional, reputational and relational advantage, these advantages can mediate the impact of knowledge acquisition and installation support, innovative OEM endorsement and specific asset investment, respectively (Joshi, 2017).
- Lastly, know-how and organizational learning are potential barriers to organizational innovation adoption which can be lowered through institutions such as consultants, service bureaus and technology simplification (Attewell, 1992).

## 4.5 Previous Studies on Driver Monitoring Systems

Although little research has been made on advanced DMS specifically, some studies have examined acceptance of similar products. In order to better understand what is already known about acceptance of products or technologies similar to DMS, this chapter attempts to provide

some insights into potential barriers to acceptance and adoption of Advanced Driver Assistance Systems.

According to Viktorová & Šucha (2018), Advanced Driver Assistance Systems (ADAS) will not deliver the benefits intended by their designers if they are not known and accepted by the drivers. The authors surveyed 526 Czech drivers and the results showed that roughly half of the drivers were not aware of more than the existence of various ADAS. More than 70% did not drive with such systems yet. A majority of the systems were desired by more than half of the respondents, but most of the respondents were not willing to pay extra money for the systems. The authors conclude that thorough driver education about ADA-systems' functions and limitations is required to increase knowledge and acceptance (Viktorová & Šucha, 2018). The respondents in this study were asked about the following systems: Adaptive Cruise Control, Forward Collision Warning, Lane Departure Warning, Blind Spot Monitoring, Driver Drowsiness Detection, Traffic Sign Recognition and Automatic High Beams (Viktorová & Šucha 2018).

Other barriers for using ADAS are a high purchasing and/or maintenance price (Viktorová & Šucha, 2018), as well as a lack of perceived usefulness, undesired system feedback, a lack of trust in the system, unwillingness to hand over control of the situation and the difficulty of system operation (Choi *et al*., 2016; European Commission - Eurobarometer, 2006; Ghazizadeh & Lee, 2014; Kyriakidis *et al*., 2014; Trübswetter & Bengler, 2013).

In his PhD dissertation, Planing (2014) found that perceived safety and comfort benefits are the most decisive factors for acceptance of Advanced Driver Assistance Systems (see figure 5). On the other hand, desire to exert control most strongly supports resistance to such technology, meaning that a strong personal motivation to exert power significantly reduces acceptance of ADAS. Group differences reveal that women and younger individuals are more likely to purchase driver-assistance systems than males and older individuals. Planing (2014) states that the industry ought to focus its attention on direct communication of safety and comfort benefits at the point of sale. First experiences strongly support acceptance of the technology, which is why both industry and legislation should aim for increasing initial usage by providing test drive opportunities and/or governmental incentives for usage. Lastly, Planing (2014) states it could be promising to develop target-group oriented marketing

measures with regard to female and younger drivers, as these groups will probably be early adopters in the case of driver-assistance systems (Planing, 2014).

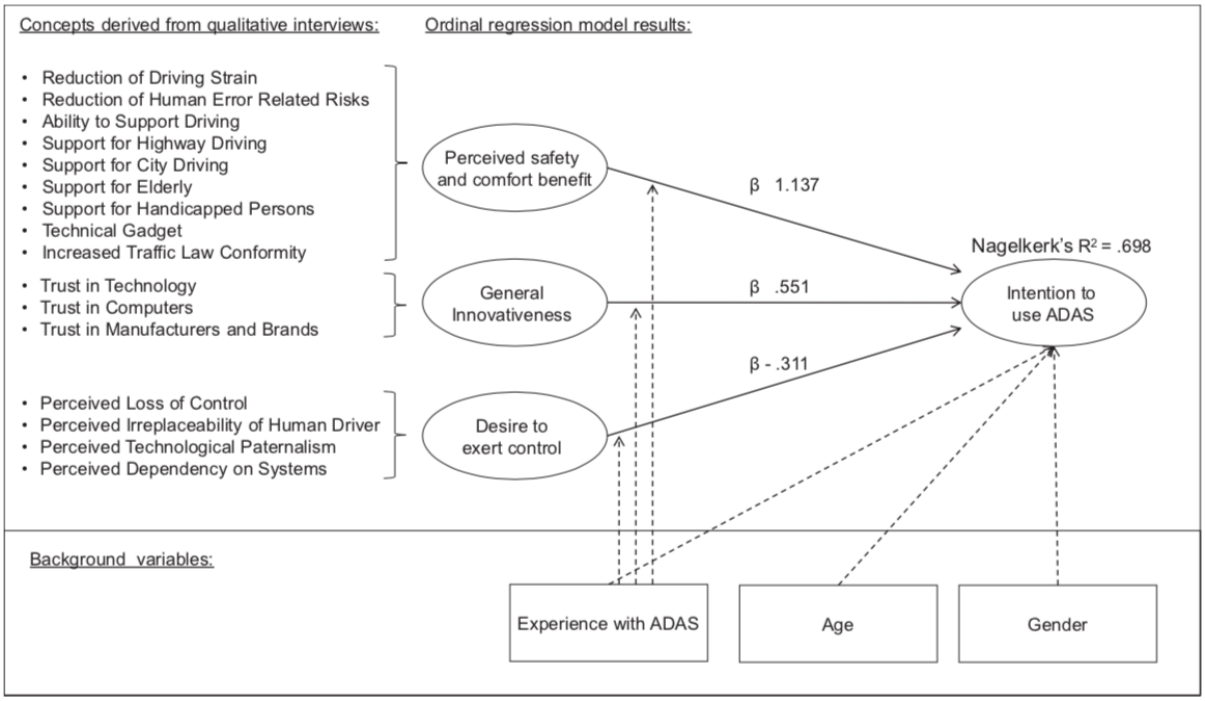


Figure 5: Conceptual model from Planing (2014, p. 263)

In summary:

- Driver knowledge and acceptance is necessary to ensure that ADAS delivers the intended benefits (Viktorová & Sucha, 2018).
- Other barriers for ADAS implementation include high purchasing and maintenance prices, lack of perceived usefulness, undesired system feedback, lack of trust in the system, unwillingness to hand over control of the situation and difficulty of system operation (Choi *et al.*, 2016; European Commission - Eurobarometer, 2006; Ghazizadeh & Lee, 2014; Kyriakidis *et al.*, 2014; Trübswetter & Bengler, 2013).
- Perceived safety and comfort benefits are decisive factors for acceptance of ADAS, whereas a desire to exert control strongly supports resistance to ADAS (Planing, 2014).
- Women and younger individuals are more likely to purchase ADAS than males and older individuals (Planing, 2014).

# 5. Results

In this chapter of the report, the results of the quantitative survey as well as the qualitative interviews will be presented. The quantitative study found that a majority of the respondents have a positive attitude toward DMS. Most of the respondents would also feel safer with such a system installed in their vehicle. However, some number of respondents are skeptical towards the DMS' ability to prevent accidents. In addition, almost a fourth of the respondents have data- or integrity related concerns. The qualitative results show a number of obstacles for DMS adoption mentioned by the respondents, as well as some indications regarding what could accelerate DMS adoption in the haulage and bus industry.

## 5.1 Results of the quantitative study

The aim of the quantitative study is to investigate car users' attitudes toward Driver Monitoring, as well as how income, age, educational level, time in the workforce, having been in a traffic accident, and some other variables could affect attitudes toward Driver Monitoring. The purpose is to gain knowledge about the end users of Driver Monitoring Systems (or DMS for short) and to draw some conclusions regarding what could affect attitudes toward Driver Monitoring. This will be done by answering the following research questions:

*What attitudes do future end-users of Driver Monitoring Systems have toward Driver Monitoring?*

*Which demographic characteristics and experiences can have an effect on future end users' attitudes toward Driver Monitoring Systems?*

### 5.1.1 What attitudes do future end-users of DMS have toward DMS?

As we can see in table 7, a majority of respondents (64.7 %) state that they would feel good or very good about driving a car with a DMS. Only 9.4 percent state that they would feel bad or very bad, and 25.9 percent state that they would feel neither good nor bad about driving a car with a DMS.

**On a scale of 1-5, how would you feel about driving a car with a Driver Monitoring System?**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Very bad | 2 | 2.4 | 2.4 | 2.4 |
| | Bad | 6 | 7.1 | 7.1 | 9.4 |
| | Neither good or bad | 22 | 25.9 | 25.9 | 35.3 |
| | Good | 21 | 24.7 | 24.7 | 60.0 |
| | Very good | 34 | 40.0 | 40.0 | 100.0 |
| | Total | 85 | 100.0 | 100.0 | |

*Table 7*

Observing table 8, we can see that 56.5 percent of respondents would feel safer or much safer if their car had a DMS. 4.7 percent would feel less safe. No respondents would feel much less safe, and 38.8 percent of respondents would neither feel less safe or safer if their car had a DMS. Thus, comparing table 7 and table 8, a larger number of respondents would feel good about driving a car with a DMS than the number of respondents who would feel safe if their car had a DMS.

**On a scale of 1-5, how much safer would you feel if your car had a Driver Monitoring System?**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Less safe | 4 | 4.7 | 4.7 | 4.7 |
| | Neither less or more safe | 33 | 38.8 | 38.8 | 43.5 |
| | Safer | 31 | 36.5 | 36.5 | 80.0 |
| | Much safer | 17 | 20.0 | 20.0 | 100.0 |
| | Total | 85 | 100.0 | 100.0 | |

*Table 8*

Looking at figure 6, we can see that a majority of respondents (59 out of 85 respondents or 69.41 percent) would rather buy a car with a DMS than without a DMS if they bought a car today.

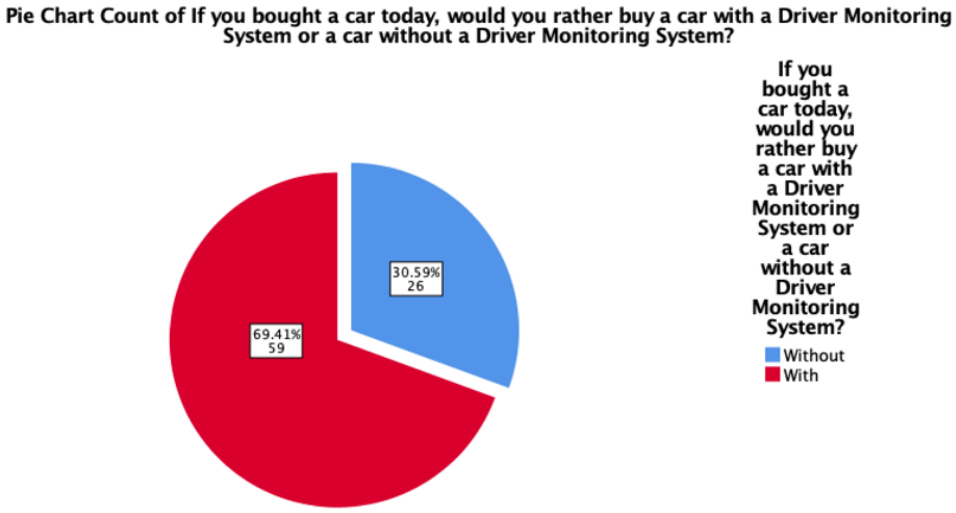


*Figure 6*

Observing figure 7, we can see that 53 respondents, or 62.35 percent, have been involved in a traffic accident.

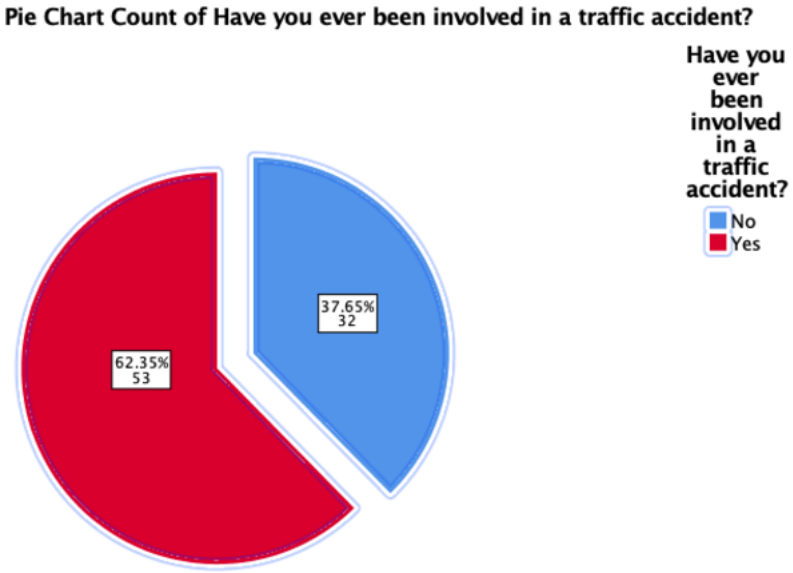


*Figure 7*

Of the respondents that had been involved in a traffic accident, a majority (76.27 percent) believe that it could not have been avoided with a DMS. Only 14 respondents believe that the accident could have been avoided with a DMS (see figure 8). It seems as if 59 people responded to whether or not the accident could have been avoided with a DMS, which is 6 more than responded that they have been involved in a traffic accident. This is likely because

of an error in the questionnaire, which enabled respondents who did not state that they have been involved in a traffic accident to answer the follow-up question.

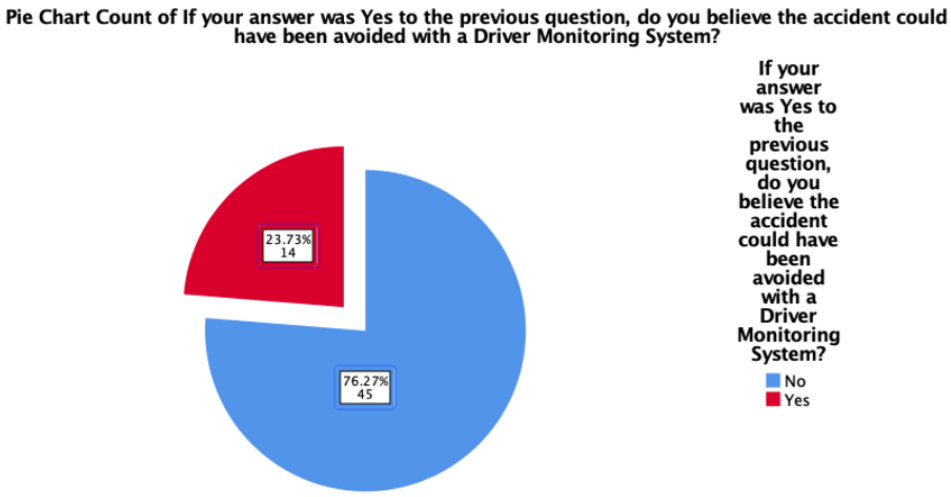


*Figure 8*

By observing table 9, we can conclude that a majority of respondents would feel safer or much safer if every car had a DMS (73 percent). 22.4 percent of respondents would neither feel safer or less safe, and 4.7 percent would feel less safe if every car had a DMS.

**On a scale of 1-5, how much safer would you feel if every car had a Driver Monitoring System?**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Less safe | 4 | 4.7 | 4.7 | 4.7 |
| | Neither more or less safe | 19 | 22.4 | 22.4 | 27.1 |
| | Safer | 40 | 47.1 | 47.1 | 74.1 |
| | Much safer | 22 | 25.9 | 25.9 | 100.0 |
| | Total | 85 | 100.0 | 100.0 | |

*Table 9*

By observing table 10, we can see that a majority of respondents would prefer if a DMS warned them too much (69.4 percent) rather than too little (30.6 percent).

**One feature of a Driver Monitoring System is to warn the driver if there are signs that he/she is on the verge of falling asleep. If your car would have a Driver Monitoring System today, would you rather the system warned you too much (i.e. sometimes when you are not actually tired), or would you rather the system warned you too little (i.e. does not warn you in some cases when it should)?**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Too little | 26 | 30.6 | 30.6 | 30.6 |
| | Too much | 59 | 69.4 | 69.4 | 100.0 |
| | Total | 85 | 100.0 | 100.0 | |

*Table 10*

In the questionnaire, the respondents had the possibility of giving a free-text answer to the question "If any, please indicate what concerns you might have about Driver Monitoring". A recurring type of concern were concerns regarding data collection, data storage, data utilization and personal integrity. In order to see how many of the respondents felt this way, the concerns were categorized according to this theme, in order to see how many in total of the respondents that had any data-related concerns. As shown in table 11, 22.4 percent of all 85 respondents had data related concerns. Of the respondents who expressed concerns, 43.2 percent were data related. Other concerns expressed were more fragmented and less uniform, but some less recurring concerns were related to price, vehicle autonomy and system reliability. By far, most concerns were related to how the data is collected, stored, and shared.

**Data-related concerns**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | No data-related concerns | 25 | 29.4 | 56.8 | 56.8 |
| | Has data related concerns | 19 | 22.4 | 43.2 | 100.0 |
| | Total | 44 | 51.8 | 100.0 | |
| Missing | System | 41 | 48.2 | | |
| Total | | 85 | 100.0 | | |

*Table 11*

### 5.1.2 Which demographic characteristics and experiences can have an effect on future end users' attitudes toward DMS?

In order to determine what effect some of the demographic characteristics and experiences included in this study could have on the attitudes toward driver monitoring systems, three multivariate regression analyses were conducted. The results of these analyses can be found in table 14 through 16. In each of these analyses, nine models were included where each of the independent variables were introduced stepwise. The regressions are to be viewed as exploratory in the sense that they aim to explain what, if any, variables help explain the variance in the independent variable for each set of models. Some hypotheses regarding yearly income as a predictor of willingness to buy a car with a DMS, having been in a traffic accident as a predictor of tendency to feel safer/less safe with a DMS, could be made. However, since the main purpose of this study is not to prove a set of hypotheses, but rather to explore what the attitudes towards Driver Monitoring among end-users are, as well as what could explain these attitudes, these regressions should be viewed as attempts to create hypotheses regarding predictors of attitudes toward Driver Monitoring, rather than proving or disproving such hypotheses.

#### 5.1.2.1 Explanation of regression output, values and variable coding

From each of the regression tables, we can see the output of the nine regression models exploring what effects nine variables have on how one would feel about driving a car with a DMS, how much safer one would feel if every car had a DMS, and whether or not one would want to buy a car with a DMS. Within each cell, the B-coefficient is shown, followed by the standard deviation within brackets. The B-coefficient tells us how large the effect of an independent variable is on the dependent variable (if the B-coefficient is 0.5, one step up on the scale of the independent variable causes a 0.5 step up on the scale of the dependent variable if the effect is significant). If the B-coefficient is statistically significant at the p = <.001 level, the B-coefficient is followed by three asterisks. If the B-coefficient is significant at the p = <.01 level, it is followed by two asterisks. If it is significant at the p<.05 level, the B-coefficient is followed by one asterisk. If the B-coefficient is not statistically significant, there is no asterisk following the B-coefficient. If the B-coefficient is not statistically significant, the B-coefficient of the variable is not certain enough to be considered as having an effect. In the last two rows of the regression table, the R-square and Adjusted R-square values are shown. These values give us an indication of the quality of the models. It can be

read as the percentage of the variance in the dependent variable explained by the independent variables included and is a value between 0 and 1. As such, the higher R-square and Adjusted R-square, the better the model explains the variance in the dependent variable. Furthermore, when many variables are included (which is the case in some of the models), there is a tendency for R-square to increase without Adjusted R-square increasing. As such, Adjusted R-square is a more rigid measurement, and an increasing distance between R-square and Adjusted R-square could be a sign that the model is including independent variables that are not necessarily helping to explain the variance in the dependent variable. The independent and dependent variables included and the way they have been coded is shown in table 12 and 13.

| **Variable scale** / **Variable name** | **0** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| **Traffic accident** | Has not been involved in a traffic accident | Has been involved in traffic accident | | | | |
| **Gender** | Female | Male | | | | |
| **Age** | | 18-29 | 30-39 | 40-49 | 50-59 | >60 |
| **Years in work force** | | 1-10 | 11-20 | 21-30 | 31-40 | >40 |
| **Educational level** | | Has not completed high school | High school graduate | University, B.Sc | University, M.Sc | PhD |
| **Yearly income** | | 0-180 000 SEK | 180 000 – 360 000 SEK | 360 000 – 540 000 SEK | 540 000 – 720 000 SEK | >720 000 SEK |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Work requires car** | Work does not require one to drive a car | Work does require one to drive a car | | | | |
| **Has bought brand-new car** | Has not bought a brand-new car | Has bought a brand-new car | | | | |
| **Frequency of driving** | | Every day | One or more times per week, but not every day | One or more times per month, but not every week | One or more times per year, but not every month | |

*Table 12: Independent variable coding*

| **Variable scale** / **Variable name** | **0** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| **How would you feel about driving a car with a DMS?** | | Very bad | Bad | Neither good nor bad | Good | Very good |
| **Would you rather buy a car with a DMS or without a DMS** | Without | With | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **On a scale of 1-5, how much safer would you feel if every car had a DMS?** | | Much less safe | Less safe | Neither less safe or more safe | Safer | Much safer |

*Table 13: Dependent variable coding*

#### 5.1.2.2 Regression Analysis

Looking first at table 14, we can observe the effects of nine independent variables on how the respondents would feel about driving a car with a DMS. Gender is the only variable which has a statistically significant effect on the dependent variable throughout eight of the nine models (all models in which it is included). Being male seems to have a positive and statistically significant effect on how one would feel about driving a car with a DMS, meaning that if you are male, you are more likely to feel good about driving a car with a DMS. Furthermore, this effect gets stronger and keeps it significance as more independent variables are added to the model. In addition to gender, educational level seems to have a significant effect on one's tendency to feel good about driving a car with a DMS. This means that the higher the respondent's education level, the more likely it is that the respondent will feel good about driving a car with a DMS. The effect observed is significant at the $p<.05$ level, whereas the effect of being male is significant at the $p<.01$ level. In summary, the two independent variables included in this model which seem to have an effect on respondent's tendency to feel good about driving a car with a DMS are a) being male and b) having a higher education. The Adjusted R square value is 0.139 in Model 9, meaning that 13.9% of the variance in the dependent variable is explained by the variables included in the model.

*Table 14: Effects of gender and educational level on how one would feel about driving a car with a Driver Monitoring System*

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Traffic Accident | 0.085 (0.247) | 0.031 (0.240) | -0.056 (0.252) | -0.046 (0.254) | -0.034 (0.243) | -0.034 (0.244) | -0.035 (0.247) | 0.076 (0.248) | 0.083 (0.250) |
| Gender (male) | | 0.631* (0.245) | 0.665** (0.246) | 0.658* (0.248) | 0.796*** (0.241) | 0.787** (0.252) | 0.785** (0.257) | 0.787** (0.252) | 0.766** (0.257) |
| Age (older) | | | 0.094 (0.086) | -0.007 (0.210) | -0.064 (0.202) | -0.072 (0.210) | -0.073 (0.213) | 0.018 (0.213) | 0.027 (0.215) |
| Years in work force (longer) | | | | 0.112 (0.213) | 0.216 (0.206) | 0.215 (0.208) | 0.215 (0.209) | 0.178 (0.205) | 0.185 (0.207) |
| Education level (higher) | | | | | 0.396 (0.135) | 0.388* (0.148) | 0.388* (0.149) | 0.386* (0.146) | 0.382* (0.147) |
| Yearly income (higher) | | | | | | 0.015 (0.107) | 0.014 (0.109) | 0.058 (0.108) | 0.073 (0.114) |
| Work requires car | | | | | | | 0.012 (0.290) | 0.058 (0.285) | 0.077 (0.290) |
| Has bought brand new car | | | | | | | | -0.593* (0.288) | -0.558 (0.299) |
| Frequency of driving (higher) | | | | | | | | | 0.068 (0.145) |
| R Square | 0.001 | 0.079 | 0.093 | 0.096 | 0.188 | 0.188 | 0.188 | 0.232 | 0.235 |
| Adjusted R Square | -0.011 | 0.056 | 0.058 | 0.049 | 0.134 | 0.123 | 0.111 | 0.148 | 0.139 |

*** = p<.001 ** = p<.01 * = p<.05

Redirecting our attention toward table 15, which seeks to explain which variables have an effect on wanting to buy a car with a DMS, a different and less powerful story emerges. Here, the only variables which show a significant effect in any of the models are gender, educational level and yearly income. However, the effects of education and gender are only statistically significant in one of the models, and the significance of the effect of those variables disappear when yearly income is introduced to the model. As such, yearly income is significant in three out of the four models in which it is included. However, the effect is fairly small (B-coefficient between 0.093 and 0.108). In addition, the adjusted R-square value is relatively low, indicating that only between 9.1% and 7.9% of the variance in the dependent variable is explained by the independent variables included. Yearly income having an effect on one's likelihood to want to buy a car with a DMS is not an unreasonable hypothesis, but one should be cautious when drawing conclusions from these models alone, bearing in mind that the explanatory power of the models is fairly low.

*Table 15: Effects of yearly income on whether one would want to buy a car with a Driver Monitoring System*

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Traffic accident | 0.032 (0.104) | 0.016 (0.103) | 0.039 (0.109) | 0.048 (0.109) | 0.052 (0.107) | 0.051 (0.105) | 0.050 (0.106) | 0.086 (0.108) | 0.086 (0.109) |
| Gender (male) | | 0.186 (0.105) | 0.177 (0.107) | 0.171 (0.107) | 0.216* (0.106) | 0.158 (0.108) | 0.155 (0.110) | 0.156 (0.109) | 0.153 (0.175) |
| Age (older) | | | -0.025 (0.037) | -0.112 (0.091) | -0.130 (0.089) | -0.178 (0.090) | -0.179 (0.091) | -0.150 (0.093) | -0.149 (0.094) |
| Years in work force (longer) | | | | 0.096 (0.092) | 0.130 (0.091) | 0.123 (0.89) | 0.123 (0.090) | 0.111 (0.089) | 0.112 (0.090) |
| Education level (higher) | | | | | 0.129* (0.060) | 0.080 (0.063) | 0.080 (0.064) | 0.079 (0.063) | 0.079 (0.064) |
| Yearly income (higher) | | | | | | 0.093* (0.046) | 0.092 (0.047) | 0.106* (0.047) | 0.108* (0.049) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Work requires car | | | | | | | 0.016 (0.125) | 0.031 (0.124) | 0.034 (0.126) |
| Has bought brand new car | | | | | | | | -0.191 (0.125) | -0.187 (0.130) |
| Frequency of driving (higher) | | | | | | | | | 0.009 (0.063) |
| R Square | 0.001 | 0.039 | 0.045 | 0.058 | 0.113 | 0.159 | 0.159 | 0.185 | 0.185 |
| Adjusted R Square | -0.011 | 0.015 | 0.008 | 0.009 | 0.055 | 0.091 | 0.079 | 0.096 | 0.083 |

*** = p<.001 ** = p<.01 * = p<.05

Looking at table 16, we can observe the effects on the respondent's tendency to feel safer if *every* car had a DMS. Again, a low adjusted R-square value warrants caution when assessing the results from these models. That being said, two independent variables show a significant effect in any of the models. These are a) one's work requiring one to drive a car and b) ever having bought a brand-new car. If the respondent's work requires the respondent to drive a car, the respondent seems to be more likely to feel safe if every car would have a DMS. This effect is significant in two out of three models in which the variable is included. Interestingly enough, having bought a brand-new car has a negative and significant effect on feeling safer if every car had a DMS, meaning that the respondent is more likely to *not feel* safe if every car would have a DMS if the respondent has ever bought a brand-new car. However, the significance of this effect disappears in the ninth and last model. In summary, professional drivers (or potentially drivers who have to drive their car *to work*, but more on that in the method section) could have a tendency to feel safer as a result of every car having a DMS installed.

*Table 16: Effect of work requiring one to drive a car on one's tendency to feel safer if every car had a Driver Monitoring System*

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Traffic accident | -0.017 (0.189 | -0.031 (0.190) | -0.097 (0.200) | -0.093 (0.202) | -0.089 (0.201) | -0.090 (0.201) | -0.133 (0.198) | -0.46 (0.199) | -0.040 (0.200) |
| Gender (male) | | 0.156 (0.194) | 0.182 (0.195) | 0.180 (0.197) | 0.231 (0.200) | 0.177 (0.207) | 0.108 (0.206) | 0.109 (0.202) | 0.090 (0.206) |
| Age (older) | | | 0.071 (0.068) | 0.037 (0.167) | 0.016 (0.200) | -0.028 (0.173) | -0.066 (0.171) | 0.005 (0.171) | 0.014 (0.173) |
| Years in work force (longer) | | | | 0.039 (0.819) | 0.077 (0.171) | 0.070 (0.171) | 0.079 (0.168) | 0.050 (0.165) | 0.057 (0.166) |
| Education level (higher) | | | | | 0.145 (0.112) | 0.099 (0.122) | 0.113 (0.120) | 0.112 (0.117) | 0.109 (0.118) |
| Yearly income (higher) | | | | | | 0.086 (0.088) | 0.062 (0.087) | 0.096 (0.087) | 0.110 (0.091) |
| Work requires car | | | | | | | 0.463 (0.233) | 0.499* (0.229) | 0.516* (0.232) |
| Has bought brand new car | | | | | | | | -0.466* (0.231) | -0.435 (0.240) |
| Frequency of driving (higher) | | | | | | | | | 0.061 (0.116) |
| R Square | 0.000 | 0.008 | 0.022 | 0.023 | 0.044 | 0.056 | 0.104 | 0.151 | 0.154 |
| Adjusted R Square | -0.012 | -0.017 | -0.015 | -0.028 | -0.019 | -0.020 | 0.019 | 0.058 | 0.049 |

*** = p<.001 ** = p<.01 * = p<.05

In summary, the variables which have displayed a significant effect on feeling good about driving a car with a DMS are a higher educational level and being male (both effects positive). The variable displaying a significant effect on wanting to buy a car with a DMS is yearly income (positive effect). The variable displaying a significant effect on feeling safer if

every car had a DMS is work requiring one to drive a car (positive effect). It is worth to note, however, that even if these independent variables display a statistically significant effect on different attitudes toward Driver Monitoring, they do not tell us if there is an underlying causal relationship. For example, having a good education seems to increase the likelihood that one will feel better about driving a car with a DMS, but we do not know if it is the higher education itself that makes the respondent feel better about driving a car with a DMS, i.e. we do not know if there is an underlying causality. Proving a causal relationship between any of the independent variables and the dependent variables included is beyond the scope of this report.

## 5.2 Interviews with Smart Eye employees

In order to understand how Smart Eye has been successful in diffusing their current products from AS, it is important to get the perspective of key personnel, i.e. one Program/Account Manager and the VP Sales Director of AS, on how and why Smart Eye has been successful. This information could also help with understanding how Smart Eye can influence the diffusion of SAIDMS. To further understand how AIS is currently working with facilitating a successful diffusion, an interview with the Director of Business Development was conducted as well.

### 5.2.1 Program Manager

The Program Manager states that the customers that have bought Smart Eyes product, i.e. the OEMs who have awarded design wins to Smart Eyes Driver Monitoring Systems, are early adopters. They want to be in the forefront of this technology adoption. In the opinion of the respondent, the situation on the market will change as a result of changing regulations and guidelines from Euro NCAP. The OEMs who have adopted are technology leaders who want functions that are advanced. In the future, the Program Manager believes more OEMs will be interested in DMS.

According to the Program Manager, there are different reasons why customers choose Smart Eye's product. One of those reasons are that Smart Eye have decided early on that their software should be easy to move between different hardware platforms. This is important

because an OEM might have a preference regarding which hardware the software ought to run on (e.g. Texas Instruments, Nvidia, etc.). Since Smart Eye has designed the software to be compatible with different hardware platforms and processors, they can provide the opportunity to easily function on a broad range of hardware. The respondent states that one main competitor has approached this differently by providing their own hardware, which creates more difficulty for some OEMs.

Another reason why customers choose Smart Eye is that the product has good functionality. Smart Eye has consistently worked with being as robust as possible. This is, according to the respondent, a boring concept in marketing terms, but the product is stable; it does not stop working and functions in most cases. Since Smart Eye has worked with head and eye tracking for many years, the company has learned how to handle different light conditions. Smart Eye has a specific way to handle lighting, combining infrared light, cameras, filters, etc. The product works in full sunlight, which far from every product does. It is not a unique feature, but a rare feature. From experience, they can, for example, tell the tier-1 supplier how to place and handle the camera in order for the product to function in an optimal way. This is not patented or magical in any way, but it requires an understanding of how the system functions under different conditions. That is where the experience and extensive field testing comes in, according to the respondent. Furthermore, there is a strong data management team which handles all the videos, data and material which has been collected from field testing and simulations. Trained networks and systems become better the more they are trained, and having such a strong process will be a survival factor for Smart Eye, according to the respondent.

The interaction with customers, i.e. tier-1 suppliers, is an important element in Smart Eyes development process. Working together with both tier-1 suppliers and OEMs in testing the product, demonstrating product capabilities and receiving feedback on the product has been important for the development of a successful product.

Lastly, the product has a small footprint, meaning that the memory required from the hardware is smaller than that of many of the competitors' products. This has been an advantage toward the competition which requires more memory.

Key findings:

- Current customers of AS are, in the opinion of the respondent, early adopters
- Reasons for adoption are:
    - Compatibility with different hardware platforms
    - Good functionality and robustness
    - Customer interaction
    - Small footprint

### 5.2.2 VP Sales Director Automotive Solutions

The VP Sales Director of Automotive Solutions has been at Smart Eye since january 2017, i.e. roughly three years. Before being hired by Smart Eye, this person had worked at Ericsson, initially as a developer and functionality tester, but later within sales with a consultative approach. Analysing customer needs and creating solutions tailored to those needs were of essence to the role. Prior to working at Smart Eye, this person had worked in over 80 countries. The person worked with technical sales support for a few years and moved on to become the sales director of eastern europe and central asia at Ericsson. After a long career at Ericsson, the person wanted to do something else and started working at Smart Eye. The reason for starting a career at Smart Eye was that the person viewed it as a challenge. The person knew nothing about the technology and had no network in the industry. Everything was new, and this was the challenge which attracted Smart Eyes current VP Sales Director of Automotive Solutions.

The person states that the global network procured from a long experience at Ericsson has been helpful in developing business at Smart Eye. Getting access to the right information and the right people has been easier. For example, the person knows many expats who have high positions in their respective organizations. The person describes her role as closing production contracts, as well as initiating them.

When asked about why customers choose to buy DMS from Smart Eye, the respondent describes how this person has approached building a network of contacts while simultaneously positioning Smart Eye towards those potential customers. Constructing a network involved finding old business cards as well as receiving lists of attendants at different kinds of technology fairs. This person tried to travel somewhere every other week

with a fully booked schedule of visits to different leads and key persons. If the person the respondent wanted to see was not available for a full meeting, the respondent tried to meet for a coffee just to establish a relationship.

According to the respondent, Smart Eye tries to establish a relationship with both the tier-1 supplier and their direct customer, the OEM. If Smart Eye does not establish a strong relationship with the OEM, the tier-1 will be the only channel of information to the OEM. Since the tier-1 supplier often does not understand Smart Eyes technology as well as Smart Eye, this communication and these demonstrations will not be as good as they could be if Smart Eye was involved directly. For this reason, Smart Eye works actively with providing demo-kits which OEMs can use to test the product themselves, instead of relying on the tier-1 to provide an accurate description of what the product can and cannot do.

OEMs rarely recommend a specific tier-2 supplier to the tier-1 supplier. In some cases this has happened, but it is a rare occurrence. However, Smart Eye sometimes helps the OEM to write their RFQ. After the RFQ has been written and sent to the tier-1 supplier, Smart Eye takes a step back and approaches the deal through tier-1 suppliers. In some cases, Smart Eye has approach the same deal through five different tier-1 suppliers. Thus, the RFQ is sent to a plethora of tier-1 suppliers, and Smart Eye tries to approach the OEM through as many of these tier-1 suppliers as they deem necessary.

Transparency is important, according to the respondent. This person tries to treat all tier-1 suppliers in the same manner. If they lose a deal it should be through their own performance and their own competitive situation, not because of Smart Eye, according to the respondent.

In one case, Smart Eye has had problems with an existing project which put a new deal in jeopardy. The respondent states that the reason for these problems were difficulties in cooperation with the tier-1 supplier involved in the project. The OEM does not care about the tier-1 - tier 2 supplier relationship, the OEM is only interested in the solution they have bought. Despite this, Smart Eye and the tier-1 supplier were arguing about many things and the respondent said that the responsibility for the problems lies both with Smart Eye and the tier-1 supplier. Eventually, Smart Eye lost the new deal. According to the respondent, this was because of problems in the existing project. In spite of this, the OEM kept the tier-1 supplier with which Smart Eye had experienced problems. The respondent does not know

whether or not the tier-1 supplier blamed Smart Eye for the problems when communicating with the OEM, but states that this could be a reason for losing the deal.

The respondent states that there have been problems with this tier-1 supplier in more than this singular case. They are difficult to work with in general. A lot of communication is repetitive and involves answering the same questions over and over. The whole process is difficult. Furthermore, the tier-1 supplier has recently fired thousands of employees and hired new people which are new to their respective roles and lack knowledge, which results in difficulties for Smart Eye.

Lastly, the respondent has some recommendations regarding sales for Applied AI Systems. Firstly, a consultative approach is required in order to sell effectively and that how AIS positions themselves toward customers will determine their level of success. To the respondents' knowledge, there are barely any salespeople employed at AIS currently, which needs to change. In particular, young people, around the age of 40-45, will benefit the sales from AIS according to this respondent. A technical background and engineering background would benefit such a sales team. Other things that would be beneficial according to this respondent is flexibility and experience from other industries.

Key findings:

- Successful diffusion has been a result of active relationship-building with both tier-1 suppliers and OEMs
- There is an information flow from Smart Eye to both OEM and tier-1 supplier
- Some difficulties in current projects, stemming from the relationship with the tier-1 supplier, have stopped the OEM from making further adoption decisions.
- The respondent recommends the following for AIS:
    - A flexible and consultative approach towards customers
    - A young (age 40-45) sales force with a technical background, as well as experience from other industries

### 5.2.3 Director Business Development AIS

This respondent is responsible for finding and shaping the business of Applied AI Systems. The product is under development and AIS is currently trying to understand customer needs

and which customers they want to sell the product to. The idea is to sell to OEMs with lower volumes than AS (less than 100 000 vehicles) and install the product during production, to retrofit the product in already manufactured vehicles, or to buy a standalone product which can just be plugged into a vehicle.

In addition to finding customer groups, AIS is trying to find geographical markets for the product. Mainly the focus has been on China, seeing that there are many regulations regarding DMS which OEMs will need to adapt to, increasing the need for products such as the one AIS will sell.

The respondent tells the developers of the product what the customers want. During 2019, there was a number of customer visits made. From all of these customers interactions with different customers in different markets, customer information is collected and conveyed to the development team. The product owner notes this feedback, makes a list of demands and wants, and takes this into consideration in developing the product.

The respondent approximates that the sales cycle is between 2 to 4 months long. Revenues will consist of product sales and non-recurring engineering (NRE) revenue. The NRE-fee will be charged in addition to the product price for adapting the standardized product to the customers vehicle. New functionality will be rolled out in new releases of the product, which will entail a price per unit cost for the customer. Bug fixes will be calculated into the product price.

There is a plan for how much revenue should be generated 2021, 2022 and 2023. In conjunction with this revenue plan, there is a plan for how the pipeline of customers must be built progressively in order to generate this revenue. The respondent approximates that 3-5 customers are needed in the pipeline for one deal to occur. This is a high hit rate, which will be made possible through a good product, according to the respondent.

When asked what drives functionality development prior to the launch of the product, the respondent states that legislation and regulatory demands are the primary drivers of what functionality AIS decides to develop. 90% of what drives functionality prior to launch is regulatory demands, whereas 10% is customer input, according to the respondent. However,

regulatory demands and customer input sometimes overlap. The most important function is inattention, according to customer input and regulations.

The product will be maintained over time through a road map. However, this road map has not been written down yet. As soon as the first product is released, AIS will start working on the next version. According to the respondent, they will try to release a new product once a year.

The respondent states that roughly 8-10 people will be selling the product. These people will require a technical background, be able to demonstrate the product, and be able to speak english. The technical knowledge does not have to be deep, according to the respondent, as the most important thing is that the knowledge allows the person to demonstrate the system to customers. In addition, experience from the automotive industry will be required, as it is a very particular industry. Lastly, customer skills and assertiveness will be helpful in selling the product.

When asked how AIS will ensure that the sales process is structured and effective, the respondent replied that they believe it will not be structured and effective in the short term. Over time, perhaps in one year, the respondent believes it could come to resemble the sales process at AS, where there is a global sales executive and sales managers for different markets. AIS will have an organization with salespeople, sales managers and business plans, but it is not in place yet. Perhaps it will be next year, according to the respondent.

Key findings:

- The sales cycle is estimated to 2-4 months.
- Non-recurring Engineering will be performed to adapt the product to customers.
- The respondent estimates that 3-5 customers in the pipeline are required for one deal.
- The salesforce will consist of 8-10 people, who will have a technical background and experience from the automotive industry.
- The respondent believes that the sales process will not be structured and effective, initially. Over time, in approximately a year, the respondent believes it will mature.
- Regulatory demands and customer input drives 90% and 10% of functionality prior to launch, respectively.

## 5.3 Interviews with potential customers for AIS

The following interviews were conducted with potential customers for SAIDMS, i.e. haulage contractors and bus companies. The purpose of the interviews is to understand what challenges Smart Eye might come across in diffusing their product to these categories of potential customers, as well as what could help Smart Eye to accelerate diffusion. This will be done by attempting to understand if potential customers currently use any DMS in their vehicles, what the reasons are behind investing in such systems, what perceived challenges might come with investing in DMS and how these challenges can be overcome.

### 5.3.1 Lotta Björnberg, Sustainability Director at Sundfrakt

Sundfrakt is a corporation of transportation companies, consisting of around 120 businesses and more than 500 personnel. The majority of the transportation companies in Sundfrakt are one-man operations, i.e. one person with one vehicle. There are large variations between these operations and how they choose to conduct their operations.

According to Lotta, none of vehicles operated under Sundfrakt currently has DMS in their vehicles. There has been talk about it, but Lotta states that this communication has been limited (perhaps 5 minutes in total). Some of the one-man operations are not as interested in technological development as herself, but she does attempt at communicating technological opportunities as they arise.

Lotta believes they will talk about DMS more in the future. However, she believes that implementation of such systems lies at least a couple of years in the future. The reason for this is that companies are currently focused on other vehicle innovations, such as fuel innovations and other environmental sustainability-oriented solutions. In communicating with industry associations, a lot of focus has been on this kind of innovations, rather than DMS.

Investments in solutions such as DMS are usually made by the transportation companies themselves, rather than by Sundfrakt as an owner. Lotta believes that a key driver for Sundfrakt as an owner to push for DMS-implementation would be if a customer asks for it, for example if they want to ensure that drivers are not tired because they are delivering some sort of hazardous substance. A key incentive is that a customer is willing to pay for the DMS. Another key driver would be if one or more of the transportation companies within the

corporation would ask about DMS. This would make Lotta very happy, she states, and would drive her to push for implementation more quickly. “If a transportation company would throw out hook, line and sinker and contact us and say that they have encountered a DMS-system in which they are interested, we would bite instantly.”, Lotta stated. However, Lotta states that the likelihood of such a suggestion coming from one of the transportation companies is low.

One important inhibiting factor is that Sundfrakt currently is changing their economy system, which entails developing internal tools and support systems. This is something which takes focus from other kinds of investments. Sundfrakt is trying not to become too introvert, seeing that a lot of focus is on changing the economy system. When asked how she first heard of DMS, Lotta states that she herself is personally interested in technological development, as she is studying digital business development in conjunction with her employment. For these reasons, she monitors technological developments, and this helped her get in touch with DMS solutions. She believes that there are others at Sundfrakt who have knowledge about DMS, but probably no one who is as interested as she is.

Key findings:

- No vehicles operating under Sundfrakt currently have DMS.
- Communication about DMS has been limited.
- The respondent believes that DMS-implementation lies a few years in the future, since focus currently is on other kinds of vehicle innovations.
- A key driver for DMS adoption would be if a customer asks for it.
- One inhibiting factor for DMS adoption is that Sundfrakt is changing their entire economy system, which takes focus from other kinds of investments.

### 5.3.2 Martin Svensson, Vehicle Manager at Tommy Nordberghs Åkeri

Tommy Nordberghs Åkeri is a Swedish haulage contractor. In 2018, they turnover of Tommy Nordberghs åkeri was 810 134 000 SEK. Martin is together with a colleague responsible for the vehicles. Their role is to ensure that the trucks are running, that there are enough trucks for all deliveries and that the vehicles are serviced and repaired. The vehicles owned by Tommy Nordberghs Åkeri do not currently have DMS installed. However, Martin has heard of such systems. He has mostly heard of it in conjunction with personal vehicles, and has

thought to himself that it is strange that there is not more talk about having it in commercial vehicles.

Martin absolutely believes that DMS is something which could be interesting for Tommy Nordberghs Åkeri. He also believes that the company would be open to investing in such a system, provided that it does not cost too much. If one can prove that it fills a function, it could happen. The one who gets the last say in investment decisions is Stefan Nordbergh (Chief of Operations), but Martin can make suggestions. If they can show Stefan that it can provide some value, such as reductions in mobile phone usage or smoking, it could potentially result in an investment. Another way to gain buy-in with Stefan would be to get an premium reduction from the insurance company. If the DMS could make that happen, it would increase the likelihood of an investment happening.

The most important use-cases or functions of such a system would be to decrease dangerous behavior (e.g. browsing the internet on a mobile phone while operating a vehicle), and to have something to show their customers, according to Martin. Ica, Martin & Servera, Bergendahls and Elgiganten are the largest customers of Tommy Nordberghs Åkeri, and some of them have very high demands on haulage contractors. If the vehicles had DMS and they could show this to their customers, the customers would appreciate it a lot, Martin believed.

When asked about potential hindrances to investing in DMS, Martin could not think of any. The only concerns are a) that the company has a lot to do between April and August and b) how much time it would take to install in the vehicles. Besides those minor concerns, Martin could not think of any obstacles to making such an investment.

Martin does not have a strong preference between having the DMS installed prior to purchasing a vehicle or installing a box in the vehicle after it has been produced and bought. If it would be a post-production installation, he would like it to be simple to install. Martin estimates that Tommy Nordberghs Åkeri purchases 20-30 vehicles per year.

Martin did not mention the workers union or employee organizations on his own initiative, but when asked about this, he acknowledges it could be a problem. Personal integrity violation is one potential discussion that Martin mentioned could arise with employee

organizations. However, if one can show the advantages of a DMS he believes they can be convinced. Arguing for increased safety for the driver and other trafficants should do the trick, according to Martin.

Key findings:

- Vehicles owned by Tommy Nordberghs Åkeri does not currently have DMS installed.
- Martin has heard about DMS before, but mostly in conjunction with personal vehicles.
- Martin believes that DMS would be interesting for Tommy Nordberghs Åkeri and believes that the company could be open to investing in such systems, provided it does not cost too much.
- The Vehicle Managers can make suggestions for investment decisions, but the COO has the final say.
- The most important use-cases and functions would be to decrease dangerous behavior (e.g. browsing the internet on the phone while driving), and to have something to show their customers.
- Tommy Nordberghs Åkeri purchases 20-30 vehicles per year, and Martin does not have a preference between having the DMS installed pre- or post-production. However, if it is post-production, it should be simple to install.

### 5.3.3 Claes Gotthold - Safety Director at Transdev Sweden

Transdev is an international mobility company with a presence in 17 countries spanning 5 continents. In 2018, the turnover of Transdev Sweden AB was 3 038 945 MSEK.

According to the Safety Director at Transdev, the company's vehicles in Sweden do not have any camera based DMS. However, the company has developed such technology in conjunction with an external partner in France. The background to this was that one or more accidents occurred, which led to investing in increased safety measures. The technology used in France includes measuring eye movement to detect drowsiness and inattention. It is connected to a bracelet which gives off a vibration and also gives an audio warning. The system has been installed primarily in long distance buses, but not in short-distance bus traffic. The reason is that there is a difference in way of driving, where longer distance drives are generally more monotonous and thus in need of such a system. The primary reason for investing in this technology is road safety. The most important function is to make the driver attentive of when he or she loses concentration, whether this is due to inattention or drowsiness.

Being Safety Director, Claes states that he keeps an ear to the ground for new kinds of safety technology which could be used in the company's vehicles. This is how he got to hear about DMS. Beside DMS, Transdev are also looking at Geofencing, AI, autonomous vehicles and other kinds of vehicle technologies. Transdev is in contact with the Bus Industry Association (Bussbranschföreningen) regarding DMS. However, most communication regarding DMS takes place between Transdev and its vehicle suppliers. Transdev does not itself drive any larger R&D exercise with regard to DMS, but relies on its suppliers to know about the best DMS-solutions

In the case of the French long-distance buses, the DMS consists of a separate box which is installed after the vehicle has been produced. However, Claes states that Transdev wants to avoid this solution in Sweden. He would rather have the vehicle supplier (OEM) install the DMS during production, because installing an additional component post-production could create new problems in the vehicle, and responsibility for solving these problems usually lands on Transdev. If Transdev hypothetically would invest in a separate post-production system, Claes would prefer if the supplier of this box takes responsibility for integrating it with the rest of the vehicle, ensuring that no problems arise. Some suppliers mentioned were Volvo, Scania, VDL, Mercedes, Solaris and BYD.

When asked why no such system has been installed in Transdev's vehicles in Sweden, Claes mentioned three primary reasons:

1. Most of the company's buses in Sweden are short-distance buses, rendering the inattention and drowsiness features less necessary,
2. The camera surveillance law (kameraövervakningslagen),
3. Workers Union resistance toward camera surveillance of drivers.

Claes believes that key features of DMS are drowsiness and inattention and that these are not necessary for shorter distance drives. I mentioned the dangerous behavior feature, which warns the driver when he/she is talking on a handheld phone or smoking. Claes did not know about this feature, and stated that such a feature could be a potential driver for Transdev to invest in such a system. Drivers talking on handheld phones, albeit illegal, has been reported by passengers and can be considered a problem. When DriverID was mentioned, Claes stated

that they, to an extent, already have DriverID through drivers' cards which are required in order to start the vehicle.

Union resistance to DMS is a problem, according to Claes. Just like how breath alcohol ignition interlock devices (BAIID) were initially met with resistance from the Union, reaching agreements with regard to DMS will be a long process. Nowadays, BAIID systems are uncontroversial, and it seems like Claes believes this might happen with DMS in the long run as well.

To summarize, according to this interview, the most interesting feature for Transdev in Sweden is dangerous behavior detection. Since the company mostly operates short distance buses, inattention and drowsiness detection are perceived as less useful. Main perceived obstacles for DMS-implementation are Union resistance as well as compliance with surveillance legislation. The company already has a separate DMS-box installed in some French long distance buses, but want to avoid such a solution in Sweden, preferring if the vehicle supplier also supplies an already integrated DMS in the vehicles delivered. Some of Transdevs current vehicle suppliers are: Volvo, Scania, VDL, Mercedes, Solaris and BYD.

Key findings:

- Transdev has DMS in some long-distance vehicles in France.
- Transdev communicates with its vehicle manufacturers and with the Bus Industry Association about DMS.
- Claes wants to avoid post-production installation of DMS in Sweden, since responsibility for fixing problems with additional post-production components usually lands on Transdev.
- Main reasons for why DMS have not been adopted in Sweden are:
    - Most of Transdevs' buses in Sweden are short-distance buses, rendering drowsiness detection less necessary.
    - The camera surveillance law (kameraövervakningslagen) could be an issue.
    - Workers Union resistance.
- Claes did not know about dangerous behavior detection, and stated it could be a driver for adoption in Sweden, mostly because of handheld phone usage among drivers.
- Some of Transdevs vehicle suppliers are Volvo, Scania, VDL, Mercedes, Solaris and BYD.

### 5.3.4 Bengt Ohlin - Safety Director at Arriva

Arriva is an international personal mobility company with 53 000 employees in 14 European countries. In 2018, Arriva Sverige Aktiebolag had a turnover of 2 781 759 MSEK.

According to Bengt, Arriva has primarily focused on systems which aim at detecting objects and people outside the vehicle, rather than systems which aid the driver. The background to looking further into systems which can detect what is going on in front of and behind the vehicle was an unfortunate event in Stockholm, where a young girl was run over by one of Arrivas buses. They have since decided to test cab-cams, which is a driver aid that detects things in front of the vehicle which the driver cannot see. However, there is currently no testing of, or investing plans in, DMS.

One of the main obstacles to investing in systems which monitor the driver is the monitoring part, according to Bengt. In his own opinion, investing in such a system would be worthwhile if it has the potential to save only one life every year. However, the feeling that “big brother sees you” is a problem among the workers unions. When I asked what has given Bengt this perception of the Union attitude toward such technology, he referred to his experience in the industry and how Unions usually react to these sorts of technologies. Furthermore, he believes that individual drivers could take it as an accusation, perceiving that the employer does not rely on the driver to do his or her job in a good way.

In spite of DMS-investments not currently being considered, Bengt believes that such a product could be interesting for Arriva. However, he thinks that road legislation and vehicle legislation is something which would make such an investment easier. Furthermore, he believes that it can be costly to be in the absolute forefront of such investments. Installing a DMS before everyone else can be controversial and is a risk.

Bengt believes that a supplier of a DMS has to be clear about the purpose of the product, i.e. that it is about accident reduction and fatality avoidance rather than surveillance. Most of the bus-traffic operated by Arriva is short-distance, according to Bengt. An important potential use-case for the product which was mentioned several times was traffic accident investigation, i.e. understanding how and why traffic accidents occur.

Key findings:

- Arriva currently has no plans to test or invest in DMS.
- One of the main obstacles for DMS-adoption is the monitoring part, pointing to workers union resistance as a potential problem.
- Bengt believes DMS could be interesting for Arriva, but states that road legislation and vehicle legislation could make investing in DMS easier.
- Bengt believes there is a risk associated with being in the forefront of investments such as a DMS-adoption, as it could be controversial.
- For a supplier to be successful, Bengt believes that the supplier has to be clear about the purpose of the product, and that it is about accident reduction and fatality avoidance rather than surveillance.
- An important use case could be traffic accident investigation, i.e. understanding how and why accidents occur.

## 5.4 Interviews with Transport Industry Organization employees

To gain an overview of how the transport- and haulage sector views DMS and what challenges exist at an industry level for implementation, interviews were conducted with two employees at Transportföretagen (a Swedish trade organization based in the transport and safety sector) and one employee at Sveriges Åkeriföretag (a Swedish industry organization for haulage contractors).

### 5.4.1 Erik Risberg, Industry Developer at Transportföretagen

Erik Risberg is employed as Industry Developer at Transportföretagen, a Swedish trade association based in the transport- and safety sector. The association has 9 700 member companies with a total of around 221 000 employees, spanning over nine industries: road, engine, fuel, shipping, flight, bus, ports, security and forwarding.

Erik describes his role as focused on traffic safety issues and vehicle issues with a particular focus on buses. When asked about his knowledge regarding DMS, he says that he is not a technological expert. His profile is to be a generalist regarding traffic security issues. However, he knows that the technology exists and that there are some DMS that can be used, but that they have to be commercially viable.

Erik describes the knowledge about DMS as a 5 on a scale of 1 - 10. He thinks that knowledge could be higher at larger bus companies and lower at smaller bus companies. To generalize, he states that companies probably do not know a lot about such products, but they may know that they exist.

When asked why he thinks knowledge is not higher regarding DMS, he states that "seeing is believing", and that one reason that bus companies do not know much about DMS is that they have never seen the technology in real life. As such, he believes that such products need to be marketed directly towards these actors in order to create knowledge.

Erik mentioned some obstacles which might inhibit the implementation of DMS in the bus industry. One such obstacle is that the product can be perceived as a violation of the personal integrity. From the perspective of employers and employees, there is a possibility that employees perceive DMS-products as a means to superintend employees, rather than a product there to assist them and increase their safety. He believes that employee organizations (i.e. workers unions) could become somewhat defensive with regard to such a product if they perceive it as a personal integrity violation.

Another obstacle is purely economic. If bus companies and haulage contractors are to invest in such a system, they need to be able to pay for it. Margins are not great in the bus industry (ROI around 4% were mentioned during the interview), and thus the cost associated with purchasing such products needs to be mitigated somehow. Erik believes that the vehicle purchasers (i.e. bus companies and haulage contractors) will be the easiest group to convince of the benefits of such a product. However, it will be tougher to convince the employee organization. Even more difficult stakeholders to convince would be those who purchase bus services, for example the municipality of Västra Götaland (Västra Götalandsregionen) or haulage services, according to Erik.

Erik believes a pull-strategy would be the best approach. If DMS-producers can convince the customers customer (i.e. purchasers of bus- or haulage services), or even their employees, that their product is important, it will be a lot easier to sell it. Tourist bus traffic could be an easier customer to deal with, in Eriks opinion. When asked why he believes this, Erik says that it is a new product. OEMs and bus companies might understand the benefit of the product, but the bus companies need to know that they can recover the cost per vehicle.

Another way to make selling the product easier would be if one could convince insurance companies to value this product. For example, if insurance companies would reward companies which have DMS, it would be an incentive for bus companies to purchase such systems.

When asked where companies retrieve information about products such as DMS, Erik mentions a few fairs which could be good forums in which one could demonstrate the technology. These are Persontrafikmässan, which is held in october in Gothenburg. This fair is for buses, taxi and all forms of collective traffic. There is a possibility that purchasers of bus services could attend as well. Another one is Busstorget, which is in april every year, where vehicle manufacturers showcase their products. This fair is arranged by the Swedish Bus Company-association (Sveriges Bussföretag). A third meaningful place to demonstrate the product could be at truck- and bus retailers. Erik believes this would help to explain the functionality of the product, as well as defusing potential worries regarding personal integrity violation.

Lastly, Erik states that the most important functions are inattention and drowsiness. Dangerous behavior could also be of great value, as he believes this could create an additional argument toward the customers of bus companies. Many, if not all, bus companies have policies regarding mobile phone usage. If the system could help prevent this, it would be a useful function.

Key findings:

- Erik ranks his knowledge of DMS as a 5 on a 1-10 scale, and thinks that knowledge of DMS in the industry is similar to his own.
- Obstacles for adoption mentioned are:
    - Personal integrity violation
    - Workers union resistance
    - Low margins and difficulties in motivating such an investment
- Erik believes that the vehicle purchasers (haulage contractors/bus companies) will be the easiest to convince of benefits of DMS. He believes workers unions will be tougher to convince, and that the most difficult to convince will be purchasers of bus and haulage services.
- Erik proposes a pull strategy, where purchasers of haulage and bus services are convinced to request DMS in their orders of such services.

- Busstorget and Persontrafikmässan (bus and haulage fairs) were mentioned as good forums to inform about DMS and to demonstrate the technology.

### 5.4.2 Maria Werpers-Dahl, Industry Developer at Transportföretagen

Maria is a colleague of Erik Risberg and is also an Industry Developer. Her focus is on commercial road traffic, and her background is within the haulage industry. She works with sustainable transportation and is in the process of creating a label for sustainable transportation.

Maria stated that she has pretty good knowledge of DMS, as she has had 35 drivers herself when working in the industry. She knows about the suppliers. Tiredness warners are already an optional addition to vehicles today, according to Maria. When asked about the knowledge at industry level in general, Maria believes that many contractors know that the possibility of DMS exists, but that it is a sensitive issue. The drivers do not want to be monitored. Having a camera directed at one's face could be perceived as very problematic. She also believes the workers union would not be too fond of it.

To Maria's knowledge, such systems are either an optional addition in a vehicle order or something which is installed post-production. If so, having a DMS needs to be a customer requirement for the haulage contractor. When one specifies a truck order, one cannot apply all good things because it would be too expensive, and there are no margins to motivate unnecessary investment. If a customer is willing to pay for it, it is a different story.

Maria was curious about what a driver is supposed to do if a DMS signals that the driver is too tired to drive when the driver still has driving time left according to his/her timecard. There are regulations about how much a driver is supposed to drive and rest (kör- och vilotidsförordningen) which cannot be easily discarded, and Maria doubts that a DMS would be cause for exceptions to such regulation.

Maria has not heard of any haulage contractors which consider investing in a DMS. If it is a customer demand, one would do it, but until then unnecessary costs will be avoided, according to Maria. There are no margins for it. However, Maria believes that it could be a good product for avoiding road accidents. Maria was a little concerned about whether or not

the camera will be recording or just be there as a safety measure. If is just a safety measure designed to prevent accidents, it will be easier to persuade the workers union, according to Maria.

Maria believes that contractors would prefer to have a DMS originally installed, rather than having it installed post-production. However, it could be good to have a post-production installation option as well if a customer would request for such a system to be in a vehicle, as vehicles are supposed to last for a minimum of 6 years.

The main obstacle to implementing DMS in the haulage industry is that it has to be a customer requirement. The customer has to be willing to pay. There are two main reasons customers to contractors might be willing to do so: they want the cargo to be whole after the transportation, and they want the cargo to be transported in a correct manner. Customer requirements for BAIID has started to appear, but it has taken many, many years, according to Maria.

Maria believes that most people in the industry mostly thing of drowsiness detection when thinking of DMS, but believes that inattention detection and dangerous behavior detection could be even more important. Looking away for just a second, or eating while driving, could create catastrophes, Maria stated. In addition, she believes that alarms and warnings should be transmitted to the haulage contractor, so that they can keep track of routine deficiencies. This is crucial, she stated.

Regardless of whether the product is originally installed or installed post-production, Maria believes it is best to communicate about the product together with the vehicle manufacturers. Alternatively, advertising in Trailer, Transportnytt or other industry magazines could prove beneficial. Fairs could also be good, for example the Logistics and transport fair in Gothenburg which is held in november, where both haulage buyers and haulage contractors gather.

Maria believes that DMS suppliers should make themselves known both at buyers of haulage and haulage contractors simultaneously. Usually, suppliers think of the one who buys the vehicle, but Maria believes that one has to pay double that attention to the one who buys the haulage service.

In terms of functionality priorities, Maria thinks that drowsiness, inattention and dangerous behavior detection are equally important. However, she thinks drowsiness is what is most known, which is why the other functions could deserve more attention. Both contractors and buyers will consider inattention detection and dangerous behavior detection to be important, according to Maria.

Lastly, Maria believes that DMS-technology could be a very good criterion for a sustainable transportation label, such as the one she is developing. However, criteria which are set cannot be impossible. If it costs 100 000 SEK to install post-production it is considered impossible. If it costs 20 000 SEK or even less, it is more plausible to be a criteria. Such a criteria must come from the haulage buyer, however, and is not something which Maria can set herself. In order to have DMS become a criteria for sustainable transportation, Maria would talk to the Transport Administration (Trafikverket) and large gatherings of buyers of haulage services.

Key findings:

- Driver resistance and workers union resistance were mentioned as key inhibiting factors for DMS adoption.
- DMS needs to be a customer requirement for haulage contractors if it is to be adopted, as the cost has to be motivated somehow.
- Maria believes most haulage contractors would prefer a DMS to be originally installed, rather than purchasing a component to be installed post-production.
- Maria believes drowsiness is a more well-known function associated with DMS, rather than inattention and dangerous behavior detection. Maria stated that haulage contractors and buyers of haulage services will find inattention detection and dangerous behavior detection important as well.
- DMS-technology could be a good criterion for a sustainable transport label if it is affordable, according to Maria.

### 5.4.3 Ulric Långberg, Industry and Communications Manager at Sveriges Åkeriföretag

Ulric works at Sveriges Åkeriföretag, a Swedish industry organization for haulage contractors. The organization consists of 6000 member companies, together operating 36 000 vehicles. Ulrics role is to inform about values, to make visible the societal benefits of haulage contractors, and to educate member companies within a range of areas, e.g. legal, technical and political matters.

Ulric knows that DMS-technology exists, and that it has existed for around 20 years. However, nowadays the technology is more precise than before, he states. For example, it utilizes AI and algorithms to read gazes. Earlier such systems would primarily give a warning if one looked down or to the side, according to Ulric. When asked about the knowledge about DMS in the haulage industry in general, Ulric stated that the knowledge probably is at par with his own knowledge about DMS.

Everybody working in haulage knows that tiredness is a problem, Ulric stated, and that there are hidden numbers of accidents which are due to a driver being too tired to operate the vehicle, or due to a driver being on the phone while driving. The reason for this is that drivers do not want to admit to being too tired behind the wheel, or to doing something while driving which he/she shouldn't.

When asked if he believes that haulage contractors would be interested in having DMS, Ulric made the observation that around 90% of Swedish haulage contracting consists of distances less than 300 km. There are around 9000 haulage contractors in Sweden, and Ulric believes tiredness could be an obvious problem for 500 of them. These 500 companies might be interested. However, he believes that the attitude is similar to Anti-lock Braking Systems (ABS); the haulage contractors will adapt to when ABS, or DMS, is originally installed in the vehicle.

Following up on originally installed DMS, I asked about what he believes the interest would be in a standalone post-production installed DMS in the form of a box which can be plugged into the vehicle. Ulric believes that this might be interesting for the companies, but that

haulage contractors probably will not invest in such a system if they can have it originally installed in the next vehicle they purchase.

Ulric believes that the inattention detection and dangerous behavior detection functions might be even more interesting than drowsiness to many haulage contractors, especially for companies with many employees. Ulric states that half of the haulage industry in Sweden consists of contractors with just one vehicle and a maximum of three drivers. 85% of the haulage industry in Sweden consists of companies with 1-5 vehicles, according to Ulric. He believes that the most interested segment would be larger companies than these, i.e. 15% of the industry. The smaller ones could be interested if they know that they have problems with a particularly reckless driver, Ulric states.

When asked if he believes haulage contractors would be willing to pay more for a vehicle with a DMS originally installed, Ulric seems skeptical. He compares it to airbags, which have existed for more than 20 years in trucks. It is only the past 5-8 years when companies have not opted out of having these in their trucks. There is an inertia in adopting these technologies, for different reasons. For example, some truck drivers get in and out of their vehicles often. If you have an airbag in the car, you have to have your seatbelt on all the time, otherwise you could hurt yourself if the airbag is deployed. Some haulage contractors opted out of the airbag for this reason. Sometimes what is “street smart” does not correspond with what is good on paper, Ulric states. If contractors had to pay extra, Ulric believes that maybe 30% of a certain category of contractors would be willing to do so.

Regarding how actors in the industry communicate about DMS, Ulric states that only the information made available by vehicle manufacturers is available. It is still in the advertising stage and there might have been some industry magazine which has advertised about it. Traffic safety is being discussed in general and in detail in many more areas than only tiredness. However, DMS is not a hot issue, according to Ulric. Contractors work more with scheduling than with purchasing systems which prevent tiredness-induced accidents. Svensk Åkeritidning (Swedish haulage magazine) and digital media are two good channels to reach both haulage contractors and their drivers, according to Ulric. Other places to inform the industry could be at truck fairs, such as Elmia Lastbil, Load Up North, Vårgårdaträffen and Stockholm Truck Meet.

When asked about whether or not haulage contractors are considering investing in DMS, Ulric says that he has never heard about anyone considering such an investment. It has probably been mentioned, but it is not something which is prioritized.

Ulric says that it is very hard to determine if a DMS, or any other safety system for that matter, is suitable to prevent accidents. It is very hard to know if a system has prevented an accident, because if the accident is prevented it could have been for any one of a wide range of reasons. The same goes for ABS - we never know if it is the ABS which helped or not. “It is a nightmare for a product placer to calculate the benefit of such a system - the benefit is that nothing happens!”, Ulric stated.

Main obstacles for DMS implementation in the haulage industry are:

1. Technical problems, i.e. contractors becoming test pilots for unfinished products. One would be cautious to invest in a post-production installment DMS out of fear that it will interfere with the driver in a bad way. The maturity of the system is key, Ulric says.
2. The cost is a big obstacle. The haulage industry is not an industry of high margins, so costs must be motivated and reasonable.
3. Availability of service and maintenance. For example, when breath alcohol ignition interlock devices (BAIID) were first installed in a lot of vehicles, service and maintenance was only available in larger cities and not in rural areas, which was a problem for many contractors. This problem ought to be avoided, according to Ulric.

Overcoming these obstacles, according to Ulric, entails having a solid product that works. Local service options where one can receive help would be good. In the case of BAIID, sometimes one could not start the vehicle despite being completely sober. Contractors are afraid of such problems.

When asked about what he thinks about the employee organizations opinion regarding DMS, Ulric says he believes it will be less of a problem than was BAIID. He also says that frequent drowsiness alarms could be used as an argument by the employee organization in negotiations about driving times and rest times.

Ulric believes the fastest way for DMS suppliers to spread their product is to have it originally installed in trucks. Furthermore, this is not a product which is fundamentally important for everyone in the industry. Some haulage contractors have nightly drives and long monotonous driving. These ought to be the most interested, according to Ulric. In terms of priority of functionality, Ulric believes drowsiness detection to be the least important to most haulage contractors, while inattention detection and dangerous behavior detection are probably more interesting for those with more than just a few employees.

Key findings:

- Roughly 90% of the haulage industry consists of distances less than 300km.
- Roughly 9000 haulage contractors operate in Sweden. Tiredness is an obvious problem for around 500 of those contractors.
- Inattention detection and dangerous behavior detection could be more interesting than drowsiness detection to many contractors.
- DMS would be more interesting for the 15% of haulage contractors that operate more than 5 vehicles.
- It is not probable that a majority of haulage contractors will be willing to pay more for a vehicle with a DMS installed, according to the respondent.
- Good communication channels for reaching haulage contractors and their drivers are:
    - Svensk Åkeritidning (Swedish Haulage Magazine)
    - Digital media
    - Fairs (e.g. Elmia Lastbil, Load Up North, Vårgårdaträffen, Stockholm Truck Meet)
- Ulric has never heard about a haulage contractor considering investing in DMS.
- Ulric believes it will be very difficult to determine whether or not prevented accident are because of a DMS or some other system or factor.
- Main obstacles for DMS implementation in the haulage industry are, according to Ulric:
    - Technical problems, i.e. haulage contractors becoming test pilots for unfinished products.
    - Low margins and cost related concerns.
    - Availability of service and maintenance.
- Ulric believes the fastest way to diffuse DMS would be by having it originally installed in vehicles.

## 5.5 Interview with Martin Miljeteig - Working Environment Commissioner at Transportarbetareförbundet (Transport Employee Organization)

As many respondents mentioned the employee organizations as a potential stakeholder which could be skeptical toward DMS, an interview was held with Martin Miljeteig, Working Environment Commissioner at Transportarbetareförbundet.

Martin works at the Swedish Transport Employee Organization (Transportarbetareförbundet), which has roughly 57 000 members who are employees in the transport sector. The objective of the organization is to promote the members' interests in the labor market, as well as working for political, social and economic democracy. The organization has 25 local offices in the country.

According to Martin, Transportarbetareförbundet has observed a large increase in members reporting about integrity-related issues, i.e. drivers who feel monitored and supervised for different reasons. A small development of dashcam-cases has been observed as well, where Transportarbetareförbundet has said no to the employer. In the case where the camera is flipped and is recording the driver, Martin states that it would definitely be a no as well.

Although good intentions may be good, Martin believes that driver assistance systems such as DMS will be used for the wrong purposes by some employees. Using GPS as an example, Martin recalls one incident where a driver was confronted by his employer because the employer thought he was driving too slow, pointing to the GPS-monitoring as an example of this. In that case, the driver was the only one who was keeping the speed limits. Another incident was when a driver was accused of having relations with a woman when he had stopped on the freeway, which the employer noticed by observing the GPS. This driver stated he had stopped because of a road accident that had happened, and the employer did not believe this.

When provided with Ulric's observation - that frequent drowsiness alarms could prove helpful to Transportarbetareförbundet in negotiations about driving times and rest times - Martin says that the argument holds in theory, but in reality the haulage contractor would never share that

information with Transportarbetareförbundet, rendering it implausible that such a benefit would ever be realized.

When asked about what he thinks of the EU regulation forcing OEMs to install advanced driver distraction warning systems, drowsiness detection systems and inattention detection systems, Martin says that he thinks it is an unfortunate development if warning systems are needed. Primarily, employers should learn how to plan routes and driving times according to the agreements that exist. However, if the system is only connected to the car on a closed loop system and the only purpose is to help the driver, without identifying the vehicle or driver and without recording or retaining data about the driver or vehicle (which is stated in the EU regulation), Martin does not have a problem with it. The main issue is that it should not be possible for employers to exploit the DMS to harass or supervise employees, according to Martin.

In summary, Martin's opinion is that there often are ulterior motives when arguing for installing DMS or similar systems. Two haulage contractors have installed dashcams and Transportarbetareförbundet has said no from the central organization, but have yet to decide whether or not they will report the contractors to the Data Inspection Board. Martin states that he would never accept the implementation of a monitoring system as a driver. What he might find more acceptable are systems with sensors which detect if the vehicle is swaying out of lane, connected to the outside of the vehicle. If an employer wanted to implement a DMS, Martin states that Transportarbetareförbundet would say no and try to stop it. However, if the DMS only is there to aid the driver, without providing information about the driver or the vehicle to the employer, Martin would be more accepting.

Key findings:

- Transportarbetareförbundet has a mainly a negative view of DMS and its purposes in the eyes of employers.
- Transportarbetareförbundet would try to stop employers who want to implement DMS in their vehicles.
- Martin does not believe frequent drowsiness alarms would help Transportarbetareförbundet in negotiating rest and driving times, as the employer would never share such information with Transportarbetareförbundet.

- A DMS which does not record or retain any information that can lead to the identification of the driver or a vehicle by the employer would make Martin more accepting, but he is still skeptical.

## 5.6 Summary of Results

*Summary of quantitative results*

The study found that a majority of the respondents would feel good or very good about driving a car with a DMS (64.7%). Only 9.4% would feel bad or very bad about driving a car with a DMS. In addition, a majority of respondents would feel safer or much safer if their car had a DMS (56.5%). Only 4.7% would feel less safe. Furthermore, a majority of respondents would feel safer or much safer if every car had a DMS (73%). Only 4.7% would feel less safe. 69.41% of the respondents would rather buy a car with a DMS than without a DMS. However, a majority of the respondents who have been involved in a traffic accident believe that the accident could not have been avoided with a DMS (76.27%).

When asked to indicate what concerns, if any, that the respondents might have about DMS (in free text, i.e. without given options for what concerns they could have), 44 respondents (51.8%) indicated that they have concerns. Of these, 43.2% indicated that they have data-related concerns, relating to the gathering, storing or sharing of data collected by the DMS. Of the total sample, 22.4% of the respondents indicated that they have data-related concerns. As such, the answer to research question 1, *What attitudes do future end users of Driver Monitoring Systems have toward Driver Monitoring,*the answer found in this report is that a majority have a positive attitude towards Driver Monitoring. However, there is some skepticism toward the ability of DMS to prevent accidents, as well as some concerns regarding how data will be handled.

Addressing research question 2, *Which demographic characteristics and experiences can have an effect on future end users' attitudes toward Driver Monitoring Systems?*, the answer is that gender (being male) and a higher educational level have a positive and significant effect on feeling good about driving a car with a DMS. In addition, having a higher yearly income has a positive effect on wanting to buy a car with a DMS. Lastly, work requiring one to drive a car has a positive effect on feeling safer if every car had a DMS. However, looking at the three regression tables, the only one with a fairly high explanatory power is table 14.

Model 9 in this regression table achieved an Adjusted R Square value of 0.139, telling us that the independent variables included explains 13.9% of the variance in the dependent variable. The other two tables achieved significantly lower Adjusted R Square values, indicating that other independent variables need to be included to fully understand what affects willingness to buy a car with a DMS or what makes one feel safer if every car had a DMS.

*Summary of qualitative results*

The qualitative part of this study has found that current customers of Smart Eye can be considered early adopters. Main reasons for adopting Smart Eye's product is compatibility with different hardware platforms, good functionality, good customer interaction and a small footprint in terms of memory required for the product. Furthermore, active relationship-building with both tier-1 suppliers and OEMs has been a key success factor for the diffusion of Smart Eye's earlier products. However, some difficulties in current projects stemming from problems in the relation with tier-1 suppliers have inhibited further adoption decisions, suggesting that good relationships with tier-1 suppliers and OEMs are indeed important factors for successful product diffusion.

With regard to potential customers and industry organizations, none of the respondents indicate that DMS has been adopted, or that haulage contractors or bus companies are considering such an investment. Main obstacles to DMS implementation that were mentioned included: other ongoing investments, cost concerns and low margins, fear of personal integrity violation, workers union resistance, conflicting legislation, potential technical problems and concerns regarding availability of service and maintenance.

Since cost was a frequently mentioned inhibiting factor for DMS implementation, many respondents suggested that investment in DMS would be easier to motivate from a cost-perspective if the haulage contractors' or bus companies' customers would ask for such a system to be installed in the vehicle which would perform the services purchased. Such a request would help haulage contractors and bus companies to independently make a decision to adopt DMS technology.

Many of the respondents' main associations with DMS were that such a system exists to prevent accidents caused by tiredness and drowsiness. None of the respondents were aware of inattention detection and dangerous behavior detection. Most respondents indicated that such

functionality would perhaps be as interesting as, or even more interesting than, drowsiness detection for many bus companies and haulage contractors. The study found that good communication channels for reaching haulage contractors and bus companies are fairs (e.g. Elmia Lastbil, Load Up North, Vårgårdaträffen, Stockholm Truck Meet, Busstorget and Persontrafikmässan), magazines (e.g. Swedish Haulage Magazine), as well as related digital media channels.

Another result of the study is that many of the respondents are concerned about workers union resistance. This concern has been confirmed as valid by asking Transportarbetareförbundet directly regarding their attitude towards DMS, as well as how they would react if employers try and implement it. According to this study, the transport workers union in Sweden have a negative attitude toward DMS. Transportarbetareförbundet believes there are ulterior motives among employers who want to install DMS in their vehicles.

Lastly, one respondent indicated that DMS will perhaps be the most interesting for a small segment of the haulage industry, rather than the entire industry, seeing that many haulage distances in Sweden are less than 300 km. According to the same respondent, it will be hard to determine whether accidents are prevented as a result of the DMS or some other system or factor. The fastest way to diffuse DMS for a supplier would be to have it originally installed in the vehicle. Most respondents agreed that originally installing a DMS would be the best option, although one respondent was indifferent to installing the system pre- or post-production.

# 6. Conclusions

This study set out to answer the overarching research question *How can Smart Eye influence the rate of diffusion of their product SAIDMS?* by attempting to answer what factors stakeholders among the SAIDMS value chain consider important for adoption, as well as what attitudes future end-users of DMS have toward DMS and which demographic characteristics and experiences can affect attitudes toward DMS. In this chapter, the answers to these research questions are presented.

## 6.1 What factors do stakeholders along the SAIDMS value chain consider important for adoption?

This study has found concerns among respondents regarding personal integrity, data collection and data storage, which could be a sign of a perceived incompatibility of the innovation with end-user preferences. This result has been triangulated with both qualitative and quantitative methods in this study. Furthermore, the workers union Transportarbetareförbundet is very skeptical toward DMS, signaling that driver acceptance could be an important factor for the diffusion process.

Cost is another major concern among bus companies and haulage contractors, which state that their customers must be willing to pay for DMS. This emphasizes demand factors as important for the diffusion process. Other factors found important in this study are availability of service and maintenance and the product being finished and functional at the time of adoption.

Haulage contractors and bus companies seem to be in the awareness-knowledge stage of the innovation adoption process, meaning that they know of the existence of DMS, but not much regarding product functionality or usage. When informed by some functions which respondents did not know about, respondents displayed interest in dangerous behavior detection and inattention detection, signaling that increased awareness-knowledge regarding functionality is both possible and potentially beneficial for future adoption decisions. Lastly, this study indicates that the size of the adopting firm matters for the potential interest in DMS adoption.

## 6.2 What attitudes do future end-users of Driver Monitoring Systems have toward Driver Monitoring?

The study found that most respondents would feel good or very good about driving a car with a DMS. Almost 10% would feel bad or very bad about driving a car with a DMS. In addition, slightly above half of the respondents would feel safer or much safer if their car had a DMS. Less than five percent of respondents would feel less safe. Almost three fourths of respondents would feel safer if every car had a DMS. Furthermore, almost 70% of the respondents would rather buy a car with a DMS than without one. Almost one fourth of respondents who have been involved in a traffic accident believe that the accident could have been avoided with a DMS.

Concerns among potential end users are similar to those of the stakeholders along SAIDMS value chain: personal integrity and data-related concerns are the most prominent. Almost one fourth of the total sample of respondents indicated that they have some sort of data-related concerns. However, the answer to the research question is that most respondents have a positive attitude toward Driver Monitoring.

## 6.3 Which demographic characteristics and experiences can have an effect on future end users' attitudes toward Driver Monitoring Systems?

The three demographic characteristics and experiences which had a positive and significant effect on attitudes toward Driver Monitoring Systems are being male, having a higher educational level and work requiring one to drive a car. More specifically, being male and more educated has a positive effect on feeling good about driving a car with a DMS installed, whereas work requiring one to drive a car has a positive effect on feeling safer if every car had a DMS. However, all three regression tables and their corresponding models have fairly low Adjusted R Square value, indicating that the explanatory power of the regression models are fairly low. The highest Adjusted R Square value achieved is the one in table 14, namely 0.139, indicating that the independent variables included explains 13.9% of the variance in the dependent variable. Thus, all conclusions derived from these regression models should be interpreted with some caution, as there likely are other explanatory factors at work which could help predict the variance in the dependent variables examined.

## 6.4 How can Smart Eye influence the rate of diffusion of their product SAIDMS?

According to this study, the most important actions which could increase the rate of diffusion of SAIDMS are to:

- Increase product acceptance among workers unions and drivers, as resistance among these groups could prolong the sales cycle,
- Focus marketing efforts toward larger haulage contractors,
- Increase knowledge about DMS in general and SAIDMS in particular among haulage contractors and bus companies, focusing on knowledge about inattention detection and dangerous behavior detection,
- Utilize fairs, such as Elmia Lastbil, Load Up North, Vårgårdaträffen, Stockholm Truck Meet, Busstorget and Persontrafikmässan, and magazines, such as Swedish Haulage Magazine, to reach haulage contractors, bus companies, drivers and purchasers of their services,
- If possible, provide both information availability for management of haulage and bus companies in order to increase customer value, and personal integrity-guarding measures in order to increase driver acceptance,
- Retain previous success factors of Smart Eye:
    - Compatibility with different vehicles
    - Good functionality in terms of robustness
    - Small footprint
    - Active relationship building with customers and customers-of-customers

# 7. Discussion

In this chapter, the results of the study will be discussed from a theoretical perspective and a managerial perspective. The theoretical implications come from an understanding of the findings from the theoretical framework set forth in chapter 3, whereas the managerial implications are a discussion aiming at providing managerial recommendations for Smart Eye.

## 7.1 Theoretical implications

The qualitative and the quantitative research efforts in this study have shown that concerns regarding personal integrity, data collection and data storage exist in the minds of potential adopters. This is true both for individual adopters, as shown by the quantitative results of the study, and for potential customers of Smart Eye, as well as their employees and Transportarbetareförbundet, as shown by the qualitative results of this study. These concerns can be considered an indication of uncertainty regarding compatibility (Rogers, 2003) with adopters' previous experiences, values and norms. If one's experiences, values and norms discourage being monitored, personal integrity violation could indeed prove to be a compatibility issue of not only SAIDMS, but DMS in general (and of course other products which are capable of collecting information about the user).

Furthermore, this study has shown that both haulage contractors and bus companies are concerned about how the employee organizations and employees will react to DMS implementation. The employee organization Transportarbetareförbundet has confirmed that these concerns are valid. As Viktorová & Šucha (2018) suggested, it does indeed seem likely that driver knowledge and acceptance is required in order for ADAS, and in the case of this study, DMS, to deliver the benefits intended by their designers. Thus, this study confirms Viktorovás & Šuchas (2018) findings regarding driver acceptance as a requirement for benefit delivery, but for the Swedish DMS-market rather than ADAS systems in the Czech Republic.

As the qualitative results suggest that respondents have concerns regarding costs and margins, many of whom explain that the haulage contractors' own customers must request and be willing to pay for DMS for it to be viable and motivated from a cost perspective, this study shows that supply factors are an important aspect of DMS adoption for haulage contractors and bus companies. These findings are in line with Cool et al. (1997) and Brown's (1981) critique of the traditional diffusion model, stating that it is focused too much on demand factors and not enough on supply factors. Indeed, because of low margins, many respondents stated that haulage contractors and bus companies cannot freely implement DMS without transferring the cost to a willing customer. Furthermore, as SAIDMS is a preventive innovation, demand factors, i.e. factors influencing the rewards from implementing SAIDMS, are highly uncertain. This puts even more emphasis on the importance of supply factors in the

case of diffusion of SAIDMS. In addition, the consequence of SAIDMS being a preventive innovation was confirmed by one of the respondents, who stated that it will be very difficult to determine whether or not a prevented accident is because of SAIDMS or some other system or factor.

Rogers (2003) stated the importance of communication channels, which he categorizes as cosmopolite and localite as well as mass media or interpersonal. This study has found that communication channels such as fairs, magazines and digital media are important in order to reach haulage contractors and bus companies as well as their drivers with information about SAIDMS. Magazines and digital media are to be considered mass media channels, whereas fairs can be considered somewhat more interpersonal. Furthermore, interpersonal cosmopolite channels have proven important for Smart Eye previously in building relationships with tier-1 suppliers and OEMs. Rogers (2003) suggests that mass media channels are more important in the knowledge stage of the adoption process, whereas interpersonal channels become more important in the persuasion stage. This is neither confirmed nor denied in this study. However, the potential customers contacted during this study seem to be in the awareness-knowledge stage of the adoption process - they know about the existence of DMS, but lack how-to knowledge and in-depth knowledge about the innovations functionality. Thus, interpersonal communication channels could be an important way to transmit how-to knowledge and principles-knowledge about DMS, which according to theory becomes more important in the persuasion stage of the adoption process.

Planing (2014) found that women and younger people are more likely to adopt DMS. The results of this study show no significant effect of age on the attitude toward DMS. However, this study showed that being male has a small but significant effect on feeling good about driving a car with DMS. Although likelihood of adoption and attitude toward driving a car with a DMS are two different things, one could argue that having a positive attitude toward driving a car with a DMS is something which precedes being more likely to adopt a DMS. Thus, this finding is in contrast with Planing's (2014) finding that women are more likely to adopt DMS. In addition, having a higher education level also had a significant effect on feeling good about driving a car with a DMS.

As Frambach and Schillewaert (2002) suggest, this study has found indications that the size, innovativeness and interconnectedness of adopting organizations can be positively related to

the probability of adoption of SAIDMS. As one of the respondents pointed out, the larger but fewer haulage contractors will likely be more interested in adopting DMS than will smaller, one-truck haulage firms. There seems to be some uncertainties with regard to DMS among haulage contractors, bus companies and drivers, which according to Frambach & Schillewaert (2002) can lower the probability of organizational adoption.

Fostering innovation implementation among OEMs is something which Smart Eye historically has done well, as shown by the number of design wins achieved. Joshi (2017) set forth a number of actions which suppliers can take to foster innovation implementation among OEMs, such as acquiring knowledge, providing installation support, securing endorsements from innovative OEMs and investing specific assets in the OEM relationship. This study has found that Smart Eye likely has taken many, if not all, of these actions in their interactions with OEMs and tier-1 suppliers. However, relating this to the diffusion of SAIDMS, it is important to bear in mind that similar actions could also be beneficial for fostering DMS adoption among haulage contractors and bus companies. Some respondents mentioned installation support and post-installation service and maintenance availability as important factors. In addition, some respondents stated that if the DMS can help bus companies and haulage contractors to make *their* customers happier (i.e. providing a reputational, relational and functional advantage as defined by Joshi (2017), this will likely help foster implementation of SAIDMS. As such, some actions identified as beneficial for fostering innovation implementation by Joshi (2017) have been found to be true also for some haulage contractors and bus companies. Some of these actions are confirmed by industry organization employees, which indicates that this could also hold true at industry level. However, for such a conclusion to be stated confidently further studies are required.

As Attewell (1992) mentions, know-how and organizational learning can be potential barriers to organizational innovation adoption, which can be overcome through consultancy, service bureaus and technology simplification. Indeed, uncertainty about how easy or difficult the DMS will be to operate and maintain has been mentioned in the interviews conducted with potential customers. As such, lack of know-how regarding DMS could prove to be a potential barrier for DMS adoption. Since haulage contractors, bus companies and the drivers of those buses and trucks possess less knowledge of DMS and how to repair and maintain such products than Smart Eye or OEMs, it is important that the technology is as simple to use and maintain as possible for a layman. In the case of post-production installations, it is important

for potential customers that the responsibility for maintenance and vehicle integration lies elsewhere than with the haulage contractor or bus company.

Cooper & Kleinschmidt (1987) identified three strong factors contributing to commercial success of new products: product advantage, proficiency of predevelopment activities and protocol. Regarding product advantage, Smart Eye has a sophisticated product. However, as Rogers (2003) states, investigations show that most individuals do not evaluate an innovation on the basis of scientific studies or its consequences. Instead, most people evaluate an innovation subjectively. For this reason, it is important to consider what would be a product advantage in the eyes of potential customers. Since one concern mentioned by most potential customers and industry organization employees were the issue of personal integrity violations and workers union resistance, one way to increase the relative advantage of the product could be to address these concerns in future product development and market communication. Another could be to put emphasis on dangerous behavior detection and inattention detection, as these two features were less known but equally interesting as, or even more interesting than, drowsiness detection. These things also connect to protocol, i.e. having a clear definition, prior to the product development stage, of target markets, customer needs, wants and preferences, product concepts and product specifications/requirements. Having knowledge of what will make the product advantageous in the eyes of haulage contractors, bus companies and drivers (i.e. AIS target markets) will increase the likelihood of commercial success (Cooper & Kleinschmidt, 1987).

Lastly, the theory of diffusion of innovations (Rogers, 2003) has proved useful in sensitizing me to information which is potentially relevant for the velocity with which SAIDMS will diffuse. However, the diffusion model encompasses many things, is expressed in a very general way and includes almost anything which could potentially have an effect. As such, most factors that arise can in some fashion be interpreted as “part of the model”, such as personal integrity concerns being a sign of incompatibility with values and norms. As such, I found the model useful as a guidance and framework through which I could view the quantitative and qualitative data gathered in the study, but it did not help in prioritizing and ranking the factors relative importance for the product. It is also hard to criticize the model, as it is so generally applicable. The only thing which arose from the study which was not really emphasized in the diffusion model set forth by Rogers (2003) is the importance of costs and cost transferability.

## 7.2 Managerial implications

For the management of Smart Eye, the study arrives at the following conclusions as to how Smart Eye can influence the rate of diffusion if SAIDMS.

*Knowledge of DMS*

Firstly, it is important to state that knowledge of DMS in general, among haulage contractors, bus companies and Transportarbetareförbundet, is limited. Companies and industry organizations know that the technology exists, but they do not have knowledge about its potential functionalities which extend beyond drowsiness detection. Furthermore, some respondents are wary of the purposes of DMS technology, thinking it could be used for other purposes than accident prevention, such as monitoring of employees or micro-management. With regard to knowledge of the potential functionality of DMS, one respondent pointed out that drowsiness only is an obvious problem in a small segment of the haulage industry, as a majority of distances are less than 300 km. As some respondents thought inattention detection and dangerous behavior detection can be equally interesting for bus companies and haulage contractors, increasing knowledge among these potential customers about such functionality could in turn increase the diffusion rate

As such, increasing knowledge about the purpose of DMS technology as well as its potential functionality along the entire value chain of the product could help increase acceptance and in turn the rate of diffusion of SAIDMS.

*Communication Channels*

According to this study, haulage contractors and bus companies, as well as commercial vehicle drivers and purchasers of services from these companies, can be reached through fairs, magazines and digital media. Examples of such fairs that were mentioned are Elmia Lastbil, Load Up North, Vårgårdaträffen, Stockholm Truck Meet, Busstorget and Persontrafikmässan. One example of a relevant magazine is Svensk Åkeritidning (Swedish Haulage Magazine). In order to increase knowledge and acceptance of DMS among haulage contractors, bus companies, drivers and purchasers of bus and haulage services, these channels can be utilized to:

1. Increase knowledge about functionality, such as drowsiness detection, inattention detection and dangerous behavior detection, emphasizing the latter two, as the knowledge of drowsiness detection is already fairly high;
2. Communicate the purpose of the product and Smart Eyes considerations regarding personal integrity, data collection and data privacy;
3. Create a need for DMS among purchasers of haulage services and bus services, as this will facilitate diffusion in a low-margin industry.

*Personal integrity and information trade-offs*

Secondly, many respondents, both in the qualitative and quantitative study, are concerned about data collection, data handling and personal integrity. This has been mentioned by bus companies, haulage contractors and the workers union Transportarbetareförbundet. However, the management of haulage contractors and bus companies perceive some benefit in being able to gather and analyze information related to routine anomalies and road accidents, which might as well be a good selling point toward such customers.

As far as European legislation is concerned, DMS will be installed in all new vehicles being produced by 2026. However, the question is *how fast* these DMS will be installed, and *which* DMS will be installed. With regard to the market of commercial vehicles, it seems as if haulage contractors and bus companies might have trouble gaining acceptance among drivers and workers unions. For this reason, one way to gain a competitive edge towards competing products could be to create a product which facilitates negotiation processes between Smart Eye's customers and workers unions, by having the perspective of personal integrity when developing the product (i.e. management not having the possibility of identifying individual vehicles or drivers centrally). If the product is easy to accept for the drivers, which is deemed necessary by Viktorová & Šucha (2018), and the workers union, this might make diffusion among haulage contractors and bus companies faster, as it would increase compatibility with end-users.

However, if valuable information is not made available for the management of haulage contractors and bus companies, they might deem the product less useful for the purpose of gaining knowledge regarding routine anomalies and road accident causes. As such, Smart

Eye is left with three options, A) developing a product which makes the most out of valuable information, making this information available to management within companies while simultaneously complying with GDPR, B) developing a product which focuses on preserving the personal integrity of the user of the product, while simultaneously delivering the intended safety benefits, or C) trying to make the product protect the personal integrity of its user while simultaneously providing aggregated information which is useful for the customer.. Both alternative A and B are risky; alternative A creates a risk of tough negotiations between the workers union and the haulage contractor/bus company, which could in turn prolong the estimated sales cycle of 2-4 months. Alternative B, however, creates a risk of creating a product which does not deliver some of the perceived benefits to the customer. In order to choose between alternative A or B, Smart Eye ought to know which of the parameters are most important to the customer: value and utilization of information or acceptance among end-users and workers unions.

Alternative C, which is trying to do both A and B simultaneously, is possibly trickier, but if successful will deliver both the benefit of information utilization *and* the preservation of the personal integrity of the drivers.

*Success factors for AS*

Previous success factors for Smart Eye are:

- Compatibility with different hardware platforms
- Good functionality in terms of robustness
- Small footprint in terms of required memory
- Active relationship-building with both tier-1 suppliers and OEMs
- A consultative and transparent approach toward both tier-1 suppliers and OEMs

As such, keeping these success factors in mind when diffusing SAIDMS will likely increase the rate of diffusion of the product. This study puts emphasis on building strong relationships with customers (i.e. haulage contractors and bus companies) and creating knowledge and acceptance for the product along the entire value chain.

*Potential obstacles*

The results of this study suggest the following potential obstacles, as perceived by the respondents, which could potentially decrease the rate of diffusion of SAIDMS:

- The customer having other ongoing investments or major ongoing changes affecting the organization,
- Cost concerns and low margins, as many respondents said that a requirement for DMS adoption is that their customers are willing to pay for it,
- Fear of personal integrity violations as a result of DMS adoption, which was confirmed by both the qualitative and quantitative research efforts,
- Workers union resistance which could potentially prolong the sales cycle,
- Conflicting legislation, i.e. national legislation preventing the adoption of a DMS in company vehicles,
- Potential technical problems, i.e. becoming the test pilot for an unfinished product, and unavailability of service and maintenance, i.e. service and maintenance for the product only being available in larger cities.

# 8. Suggestions for future research

Replicating this study in an international setting with not only Swedish potential customers could provide further insights with regard to what factors are important for the diffusion of DMS in general and SAIDMS in particular. Conducting the quantitative study only on commercial drivers could provide more accurate conclusions regarding this particular group of end-users. In addition, asking purchasers of haulage and bus services what could make them interested in choosing suppliers who have adopted DMS could prove useful in a future study.

One area which could require further exploration is personal integrity as a compatibility issue. How do concerns regarding personal integrity and data collection/storage affect the probability of adoption of technologies which collect and store data? This can be measured and could provide an interesting development of the compatibility-factor of the innovation itself which Rogers (2003) found is important for an innovation's potential diffusion.

Furthermore, an interesting theme in diffusion research which has not been explicitly stated in this study is the adopter category distribution across value chains from early suppliers to purchasers of finished products or end-users. This study has given some indication that there is likely a higher concentration of innovators and early adopters further up in the value chain (among tier-2 suppliers, tier-1 suppliers and OEMs), and a higher concentration of late adopters and laggards later in the value chain (among haulage contractors, bus companies and commercial drivers). Since this has not been verified or falsified within this study, this could be an interesting future contribution to diffusion studies, as it could help us understand how different products diffuse in different industries based on adopter category concentration in the value chains of those industries.

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# 10. Appendix

## 10.1 Questionnaire for quantitative study

In this section, I will describe the questionnaire which the respondents filled in, as well as the options which the respondents could choose from when answering the different questions. The questionnaire included a brief description of the EU-legislation that is going to lead to the implementation of Driver Monitoring Systems, as well as a brief description of what a Driver Monitoring System is. The questions that have been provided to the respondents of the survey carried out in this study are as follows:

**About Driver Monitoring**

Driver Monitoring is a way to monitor a drivers' level of drowsiness, fatigue, eye movement, head position and other kinds of information that can help the Driver Monitoring System to recognize if the driver is in a good state to drive. The purpose of such a system is to increase driver safety and to reduce the number of accidents and fatal accidents happening on the roads. The information described above is gathered through infrared cameras placed in the car, which are pointed toward the driver, registering, recording and reacting to what the driver is doing at all times. By 2026, advanced driver distraction warning systems, such as Driver Monitoring Systems, will be a legal requirement in the EU for all new vehicles (Official Journal of the European Union, 2019).

**SECTION 1: About Driver Monitoring:**

On a scale from 1-5, how would you feel about driving a car with a Driver Monitoring System?

- 1 = Very bad
- 5 = Very good

On a scale of 1-5, how much safer would you feel if your car had a Driver Monitoring System?

- 1 – Much less safe
- 5 – Much safer

On a scale of 1-5, how often do you use your seatbelt?

- 1 – Never
- 5 – Every time

If you bought a car today, would you rather buy a car with a Driver Monitoring System or a car without a Driver Monitoring System?

- With
- Without

If any, please indicate what concerns or worries you might have about Driver Monitoring.

- Free text, optional

Have you ever been involved in a traffic accident?

- Yes
- No

If your answer was Yes to the previous question, do you believe the accident could have been avoided with a Driver Monitoring System?

- Yes
- No

On a scale of 1-5, how much safer would you feel if every car had a Driver Monitoring System?

- 1 = Much less safe
- 5 = Much safer

One feature of a Driver Monitoring System is to warn the driver if there are signs that he/she is on the verge of falling asleep. If your car would have a Driver Monitoring System today, would you rather the system warned you too much (i.e. sometimes when you are not actually tired), or would you rather the system warned you too little (i.e. does not warn you in some cases when it should)?

- I would prefer the system warned me too much
- I would prefer the system warned me too little

**SECTION 2: About the respondent:**

Highest educational level completed.

- Have not completed high school
- High school
- University – B.Sc
- University – M.Sc
- PhD

Age

- Free text (number)

Nationality

- Free text

Gender

- Male
- Female

Approximate no. of years in work force

- Free text (number)

Yearly income pre-tax

- 0 SEK -180 000 SEK or 0 EUR - 17 280 EUR
- 180 000 SEK - 360 000 SEK or 17 280 EUR - 34 560 EUR
- 360 000 SEK - 540 000 SEK or 34 560 EUR - 51 840 EUR
- 540 000 SEK - 720 000 SEK or 51 840 EUR - 69 120 EUR
- More than 720 000 SEK or 69 120 EUR

Do you currently own a car?

- Yes
- No

How often do you drive a car?

- Every day
- One or more times per week, but not every day
- One or more times per month, but not every week
- One or more times per year, but not every month

Have you ever bought a brand new car?

- Yes
- No

Was your current car completely new when you bought it, or had it been used before?

- Completely new
- Used before
- Do not currently own a car

Does your work require you to drive a car?

- Yes
- No

## 10.2 Example interview guide, Smart Eye employee

The purpose of the interview is to:

a) understand which moments and considerations are crucial in customer X:s adoption process of DMS from Smart Eye,
b) understand how long it took from customer X:s knowledge of DMS in general or Smart Eyes DMS in particular until customer X decided to purchase such systems,
c) understand how the decision-making process looks for the tier-1 supplier which Smart Eye delivered to which in turn delivered to customer X, which interactions between Smart Eye and the tier-1 supplier/customer X have taken place and how they have affected the adoption process,
d) understand how Smart Eye can take an active role in encouraging the tier-1 supplier and/or customer X to recommend the purchased system to other potential customers.

Questions:

1. When did you first come in contact with customer X?
2. When did Smart Eye first come in contact with customer X?
3. Did Smart Eye come in contact with customer X first or the tier-1 which supplies customer X first?
4. Who took initiative to initial contact with customer X?
5. Who took initiative to initial contact with the tier-1 supplier?
6. Did customer X have knowledge of DMS at the time of initial contact with Smart Eye?
7. Did the tier-1 supplier have knowledge of DMS at the time of initial contact with Smart Eye?
8. How extensive was this knowledge?
9. How long did it take from initial contact with tier-1 supplier and/or customer X until the tier-1 supplier and/or customer X decided to purchase Smart Eyes product?
10. How would you describe the process from initial contact with customer X and/or the tier-1 supplier until the deal was done?
    a. Which moments were crucial?
    b. Which were the most important stakeholders in this process?
    c. How was the purchasing decision made at the tier-1 supplier and customer X, respectively?

    d. Which factors in Smart Eyes product do you believe were most important for customer X and the tier-1 supplier, respectively?
    e. Approximately how often did Smart Eye interact with the tier-1 supplier in this process?
    f. Approximately how often did Smart Eye interact with customer X in this process?
11. How satisfied do you believe customer X and the tier-1 supplier are after the deal, respectively?
12. What feedback has Smart Eye received from the tier-1 supplier and customer X regarding the product and customer interaction?
13. How does Smart Eye work with implementing this feedback in future customer interaction and product development?
14. How likely do you believe it is that customer X and/or the tier-1 supplier, own their own initiative, will discuss Smart Eyes product within their respective organizations?
15. How likely do you believe it is that customer X and/or the tier-1 supplier, own their own initiative, will discuss Smart Eyes product outside their respective organizations?
16. How likely do you believe it is that customer X and/or the tier-1 supplier, own their own initiative, will discuss Smart Eyes product with others than direct colleagues (e.g. friends, more distant professional contacts, family, etc.)?
17. According to you, what can Smart Eye do to encourage customer X and/or the tier-1 supplier to talk about and recommend the product to other organizations and individuals?
18. What organization do you perceive has the greatest ability to increase knowledge about DMS in general and Smart Eyes product in particular?
19. Which individuals do you perceive has greatest ability to increase knowledge about DMS in general and Smart Eyes product in particular?
20. What organization do you perceive has the greatest ability to convince other organizations to purchase DMS in general and Smart Eyes products in particular?
21. Is there anyone at Smart Eye I should interview to gain further insights into customer X:s adoption process?
22. How can I get in contact with key individuals in the purchase decision process at the tier-1 supplier company and customer X company, respectively?

## 10.3 Example of interview guide, potential customer

1. What is your role at company X?
2. Do your vehicles currently have any kind of Driver Monitoring System installed?

**If 2 = Yes, ask the following questions**

3. Do all vehicles have DMS or just some?
4. Have you bought DMS or is it something you are using on a test-basis?
5. Which are the main reasons for your company investing in DMS?
6. What made you buy or test the particular DMS that you are using today?
7. What functions or features of the DMS are most important to you?
8. How did your company first hear about DMS?
9. Do you discuss DMS with other organizations in any context?
    a. Is there any industry organization with which you are in contact that handles guidelines or legislation regarding DMS?
10. Can you describe how communication regarding DMS takes place within your company?
11. What considerations were made before investing in the DMS you are currently using?
12. Are you satisfied with your current supplier of DMS? Why/why not?
13. Can you mention the name of your current supplier?

**If 2 = No, ask the following questions**

14. Do you have any knowledge of DMS? If yes, can you describe what you know about DMS?

**If 14 = No, briefly explain what DMS is:**

*DMS is a way to keep a watching eye on a drivers tiredness, drowsiness, eye movement, head position and other kinds of information which can help the DMS to gauge whether or not the driver is in a good state to operate the vehicle. The purpose of such a system is to increase driver safety and to reduce the number of accidents and fatalities connected to road safety. The information describes is gathered through cameras placed in the vehicle which are directed towards the driver, which register and react to driver movement.*

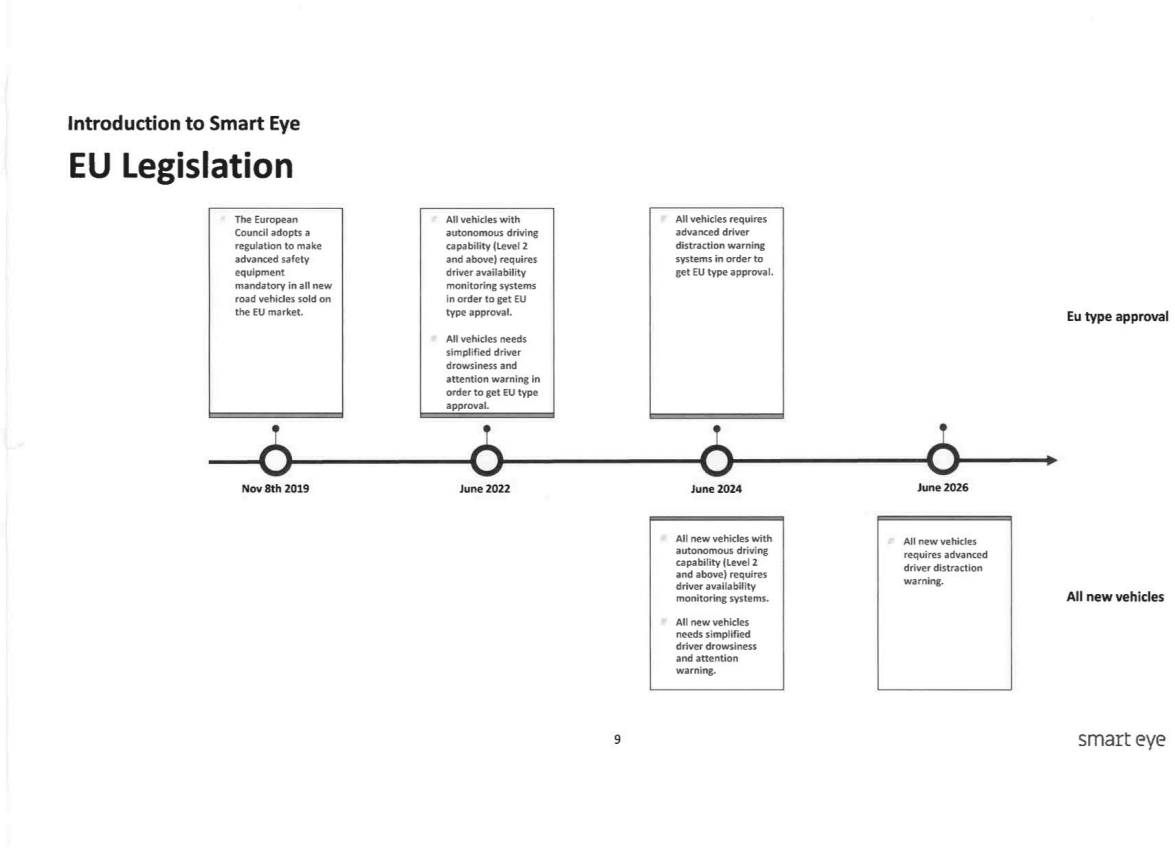
**Then ask the following questions:**

15. Do you know anyone else at your company who you think could have knowledge regarding DMS?
16. Is such a system something that your company would find interesting?
17. What could make you invest in such a system?
18. What do you think would be most important for you in a DMS?
19. What potential hindrances can you see in procuring DMS for your vehicles?
20. How could a supplier of DMS help you overcome those hindrances?

**If 14 = Yes, ask the following questions:**

21. Can you describe what you know about DMS?
22. How did you first hear of DMS?
23. Have DMS been discussed within your company?
24. Have you considered investing in DMS?
25. Have you reached a decision in the question of investing in DMS?
26. Which have been the most important factors for you in your considerations regarding DMS?
27. Which demands or requests would you have for a supplier of DMS?

# 10.4 EU Regulation timeline – DMS



# Summary of Master Thesis:

# Innovation Diffusion at Smart Eye

## 1. Introduction

The introduction of the thesis starts with giving a brief description of the economic and injury-related consequences of road accidents each year. Relating this to recent European and Chinese legislation regarding driver monitoring and advanced safety equipment, the introduction focuses in on driver monitoring systems and Smart Eye, which is a leading company in eye tracking and driver monitoring in the world. The purpose of the thesis is stated, i.e. *to investigate how Smart Eye can influence the rate of diffusion of their product Smart AI Driver Monitoring System* (SAIDMS), as well as the research questions which the thesis aim to answer:

**Overarching research question:**
How can Smart Eye influence the rate of diffusion of their product Smart AI Driver Monitoring System?

- **Qualitative research question:**
  What factors do stakeholders along the SAIDMS value chain consider important for adoption?
- **Quantitative research questions:**
  What attitudes do future end-users of Driver Monitoring Systems have toward Driver Monitoring?
  Which demographic characteristics can have an effect on future end users' attitudes toward Driver Monitoring?

Lastly, the introduction explains some limitations of the scope of the thesis, i.e. geographical limitations (Swedish respondents, companies and stakeholders), which affects the generalizability to other geographical areas. Respondents are outlined as Smart Eye employees, potential customers, industry organization employees, workers' union employees and potential end users of Driver Monitoring Systems (DMS).

# 2. DMS Industry

The second chapter of the thesis introduces the reader to the rapidly growing DMS industry, as well as a description of the product category and main functionality usually found in DMS. Three main features are drowsiness detection, inattention detection and dangerous behavior detection. These features are attained by placing a camera inside the vehicle, which monitors the driver and translates facial expressions, behavior, movement and other data input to an assessment of whether or not the driver is fit to operate the vehicle. An alarm is triggered in case the driver is falling asleep, is being inattentive or is engaging in dangerous behavior. This alerts the driver, who is then in a better position to stop the vehicle and get some rest, be more attentive or stop engaging in dangerous behavior. The chapter then continues to give a description of Smart Eye as a company, as well as the business areas which Smart Eye operate; Research Instruments (RI), Automotive Solutions (AS) and the most recent business area, Applied AI Solutions (AIS). AIS is the business area which is developing and selling SAIDMS.

After an introduction of Smart Eye, AIS and SAIDMS, the global DMS market size is provided, which was €240 million in 2019. The market growth is expected to be rapid, with a compounded annual growth rate of 49%, largely due to change in legislation. The market size is expected to reach €4 billion in 2025. The market definition of Smart Eye has previously been narrower than Driver Monitoring Systems, as they have only supplied software for these systems to tier-1 suppliers in the automotive industry. With the start of AIS and the development of SAIDMS, Smart Eye has expanded to provide complete DMS systems, with both hardware and software components, and are thus executing a downstream vertical integration to become a tier-1 supplier as well as a tier-2 supplier. SAIDMS as a product will be aimed mainly at commercial vehicle operators, such as bus enterprises and haulage enterprises, as well as Original Equipment Manufacturers (OEMs) and personal drivers.

The competitive landscape consists mainly of four direct competitors which are all small to medium enterprises; Seeing Machines (Australia), EyeSight (Israel), FotoNation (US) and Roadefend (China). Two indirect competitors are Visteon and Denso. The market concentration is high, and as Smart Eye already has the most design wins from the automotive sector among all its competitors, the company is in a good position to capture market shares as well as taking part in the natural growth of the market.

# 3. Method

In this section of the report, the methodological approach of the study and its implications for the reliability, validity and generalizability of the findings made in the study will be discussed. The qualitative data analyzed consists of 10 semi-structured interviews with potential customers of Smart Eye, industry organization employees and current employees at Smart Eye. The quantitative data analyzed consists of 85 survey responses. The literature review focuses on theories and empirical studies in the field of innovation diffusion, as well as specific research made on preventive innovations and acceptance of Driver Assistance Systems. The analysis consists of regression analyses of the quantitative data and thematic analysis of the qualitative data. At the end of the chapter, I discuss what implications the methodological choices made have for the reliability, validity and generalizability of the findings of the study.

The chapter concludes that the research design is a case study of Smart Eye and SAIDMS, and that the chosen research strategy is mixed methods. As the purpose of this study is to investigate how Smart Eye can influence the rate of diffusion of SAIDMS, and since Rogers (2003) states that the diffusion process is driven by subjective evaluations of an innovation, it seems appropriate to employ a qualitative research method in trying to understand what factors can influence the rate of diffusion of SAIDMS. Thus, the qualitative research effort in this study aims to provide an understanding of the perspective of Smart Eye on what has made them successful so far, and to examine potential customers' concerns and thoughts regarding adoption and implementation of DMS.

Notwithstanding the value of qualitative methods in generating a rich and deep understanding of the perspective of respondents, some things are better understood through asking a larger number of respondents and trying to find patterns and measurements in the sample in order to generate a better understanding of general attitudes or indicators (Bryman & Bell, 2007). Viktorová & Šucha (2018) found that Advanced Driver Assistance Systems (ADAS) will not deliver the benefits intended by their designers if they are not known and accepted by the drivers. For this reason, it is important to study the attitudes of end-users of DMS, as DMS is one kind of ADAS. Since there are far more personal and commercial drivers than there are potential direct customers for Smart Eye, and since the attitudes among these drivers can differ depending on a range of variables, a quantitative approach seems appropriate in generating an understanding about end-user attitudes and concerns regarding DMS.

The qualitative method employed in the study aims to provide an answer to the following research question:
*What factors do stakeholders along the SAIDMS value chain consider important for adoption?*

The quantitative method employed in the study aims to provide an answer to the following research questions:
*What attitudes do future end-users of Driver Monitoring Systems have toward Driver Monitoring?*

*Which demographic characteristics and experiences can have an effect on future end users' attitudes toward Driver Monitoring?*

The choice of using mixed methods is discussed critically by addressing two main arguments against the use of mixed methods. The chapter concludes that these arguments revolve around epistemological commitments connected to qualitative and quantitative methods, respectively, as well as the notion that qualitative and quantitative research are separate paradigms. As Bryman & Bell (2007) state, however, there is also a technical version of the nature of quantitative and qualitative methods. The technical version puts emphasis on the strengths of both methods and views them as compatible. The study thus assumes the technical version of the view on the compatibility of quantitative and qualitative methods.

By employing both quantitative and qualitative methods in addressing the end-users and potential direct purchasers directly, the study is able to generate findings regarding both direct customers and end-users, which according to previous research (Rogers, 2003; Viktoróva & Šucha, 2018) can both affect the rate of diffusion of an innovation. Furthermore, in the case that the quantitative and qualitative parts of the study generate similar findings, the reliability of those findings will be increased as they will have been triangulated. Triangulation in mixed-methods research means that "(...) the results of an investigation employing a method associated with one research strategy are cross-checked against the results of using a method associated with the other research strategy." (Bryman & Bell, 2007).

The qualitative data collection was performed through 10 semi-structured interviews. For a description of the qualitative respondents, see the table below.

| Name | Role | Organization |
|---|---|---|
| Anders Eliasson | Program Manager | Smart Eye |
| Snjezana Simic | VP Sales Director AS | Smart Eye |
| Magnus Brunzell | Director Business Development AIS | Smart Eye |
| Lotta Björnberg | Sustainability Director | Sundfrakt |
| Martin Svensson | Vehicle Manager | Tommy Nordberghs Åkeri |
| Claes Gotthold | Safety Director | Transdev Sweden |
| Bengt Ohlin | Safety Director | Arriva |
| Erik Risberg | Industry Developer | Transportföretagen |
| Maria Werpers-Dahl | Industry Developer | Transportföretagen |
| Ulric Långberg | Industry and Communications Manager | Sveriges Åkeriföretag |
| Martin Miljeteig | Working Environment Commissioner | Transportarbetare-förbundet |

The quantitative data collection consisted of a survey answered by 85 respondents. The sampling frame for these respondents was future end-users of DMS, i.e. anyone who will drive a car in 5 years. In retrospect, conducting the survey study on only commercial drivers would have provided a narrower population and a more accurate sampling. The sampling of qualitative respondents was a snowball sample, and the sampling of survey respondents was a convenience sample. The quantitative sample became more representative by attempting to reach a good distribution in terms of age, gender, income and education level, as people who will drive a car in 5 years will likely be well represented across all demographic dimensions. The method section reaches the conclusion that the sample is fairly even distributed across these dimensions. For a description of the survey respondents, see the table below.

| | Male | Female | | | | Total |
|---|---|---|---|---|---|---|
| **Gender** | 62.35%<br>53<br>respondents | 37.65%<br>32<br>respondents | | | | 100%<br>85<br>respondents |
| | **Has not completed high school** | **High school** | **B.Sc** | **M.Sc** | **PhD** | |
| **Educational level** | 2.41%<br>2 respondents | 28.92%<br>24<br>respondents | 36.14%<br>30<br>respondents | 31.33%<br>26<br>respondents | 1.20%<br>1 respondent | 100%<br>85<br>respondents |
| | **0 SEK – 180 000 SEK** | **180 000 SEK – 360 000 SEK** | **360 000 SEK – 540 000 SEK** | **540 000 SEK – 720 000 SEK** | **>720 000 SEK** | |
| **Yearly income** | 18.82%<br>16<br>respondents | 9.41%<br>8 respondents | 32.94%<br>28<br>respondents | 14.12%<br>12<br>respondents | 24.71%<br>21<br>respondents | 100%<br>85<br>respondents |
| | **18-29 years** | **30-39 years** | **40-49 years** | **50-59 years** | **>60 years** | |
| **Age** | 23.5%<br>20<br>respondents | 9.4%<br>8 respondents | 9.4%<br>8 respondents | 38.8%<br>33<br>respondents | 18.8%<br>16<br>respondents | 100%<br>85<br>respondents |
| | **1-10 years** | **11-20** | **21-30 years** | **31-40 years** | **>40 years** | |
| **Years in work force** | 25.9%<br>22<br>respondents | 9.4%<br>8 respondents | 18.8%<br>16<br>respondents | 32.9%<br>28<br>respondents | 11.8%<br>10<br>respondents | 100%<br>85<br>respondents |

# 4. Theoretical Framework

The theoretical framework employs Everett Rogers (2003) theory of diffusion of innovations as a point of theoretical departure of the thesis. A definition of innovation and innovation diffusion are set forth, as well as the key elements of the innovation diffusion theory. After setting the theoretical frame and point of departure, the theoretical framework elaborates on preventive innovations, i.e. innovations which aim to prevent some future, unwanted event from happening. As SAIDMS aims to prevent road accidents and traffic related fatalities and injuries, it can be referred to as a preventive innovation. The main reason this is important is that Rogers (2003) states that the relative advantage of preventive innovations is difficult to demonstrate, because the advantages occur at some future and unknown time, and may in fact not occur at all.

The chapter then reviews some studies made on innovation diffusion among organizations, as Smart Eye will mostly be selling SAIDMS to other companies down the value chain. This part of the chapter outlines some key factors in innovation diffusion among organizations, such as costs (Cool et al., 1997; Brown, 1981), product advantage, proficiency of predevelopment activites and protocol

(Cooper & Kleinschmidt, 1987), the size and innovativeness of the adopting organization (Frambach & Schillewaert, 2002), and supplier actions of importance, such as providing installation support, securing endorsements and investing specific assets (Joshi, 2017).

The chapter concludes with reviewing some previous studies conducted on DMS or similar products. This part of the chapter finds that driver acceptance is necessary for Advanced Driver Assistance Systems (ADAS) to deliver the benefits intended by the designers (Viktorová & Šucha, 2018). Moreover, lack of perceived usefulness, undesired system feedback, a lack of trust in the system, unwillingness to hand over control of the situation and the difficulty of system operation are found to be potential obstacles to adopting ADAS (Choi *et al*., 2016; European Commission - Eurobarometer, 2006; Ghazizadeh & Lee, 2014; Kyriakidis *et al*., 2014; Trübswetter & Bengler, 2013). In addition, women and younger individuals are more likely to purchase ADAS than males and older individuals, and perceived safety and comfort benefits are decisive factors for acceptance of ADAS (Planing, 2014).

# 5. Results

*Summary of quantitative results*

The study found that a majority of the respondents would feel good or very good about driving a car with a DMS (64.7%). Only 9.4% would feel bad or very bad about driving a car with a DMS. In addition, a majority of respondents would feel safer or much safer if their car had a DMS (56.5%). Only 4.7% would feel less safe. Furthermore, a majority of respondents would feel safer or much safer if every car had a DMS (73%). Only 4.7% would feel less safe. 69.41% of the respondents would rather buy a car with a DMS than without a DMS. However, a majority of the respondents who have been involved in a traffic accident believe that the accident could not have been avoided with a DMS (76.27%).

When asked to indicate what concerns, if any, that the respondents might have about DMS (in free text, i.e. without given options for what concerns they could have), 44 respondents (51.8%) indicated that they have concerns. Of these, 43.2% indicated that they have data-related concerns, relating to the gathering, storing or sharing of data collected by the DMS. Of the total sample, 22.4% of the respondents indicated that they have data-related concerns. As such, the answer to research question 1, *What attitudes do future end users of Driver Monitoring Systems have toward Driver Monitoring,*the answer found in this report is that a

majority have a positive attitude towards Driver Monitoring. However, there is some skepticism toward the ability of DMS to prevent accidents, as well as some concerns regarding how data will be handled.

Addressing research question 2, *Which demographic characteristics and experiences can have an effect on future end users' attitudes toward Driver Monitoring Systems?*, the answer is that gender (being male) and a higher educational level have a positive and significant effect on feeling good about driving a car with a DMS. In addition, having a higher yearly income has a positive effect on wanting to buy a car with a DMS. Lastly, work requiring one to drive a car has a positive effect on feeling safer if every car had a DMS. However, looking at the three regression tables, the only one with a fairly high explanatory power is table 14. Model 9 in this regression table achieved an Adjusted R Square value of 0.139, telling us that the independent variables included explains 13.9% of the variance in the dependent variable. The other two tables achieved significantly lower Adjusted R Square values, indicating that other independent variables need to be included to fully understand what affects willingness to buy a car with a DMS or what makes one feel safer if every car had a DMS.

*Summary of qualitative results*

The qualitative part of this study has found that current customers of Smart Eye can be considered early adopters. Main reasons for adopting Smart Eye's product is compatibility with different hardware platforms, good functionality, good customer interaction and a small footprint in terms of memory required for the product. Furthermore, active relationship-building with both tier-1 suppliers and OEMs has been a key success factor for the diffusion of Smart Eye's earlier products. However, some difficulties in current projects stemming from problems in the relation with tier-1 suppliers have inhibited further adoption decisions, suggesting that good relationships with tier-1 suppliers and OEMs are indeed important factors for successful product diffusion.

With regard to potential customers and industry organizations, none of the respondents indicate that DMS has been adopted, or that haulage contractors or bus companies are considering such an investment. Main obstacles to DMS implementation that were mentioned included: other ongoing investments, cost concerns and low margins, fear of personal integrity violation, workers union resistance, conflicting legislation, potential technical problems and concerns regarding availability of service and maintenance.

Since cost was a frequently mentioned inhibiting factor for DMS implementation, many respondents suggested that investment in DMS would be easier to motivate from a cost-perspective if the haulage contractors' or bus companies' customers would ask for such a system to be installed in the vehicle which would perform the services purchased. Such a request would help haulage contractors and bus companies to independently make a decision to adopt DMS technology.

Many of the respondents' main associations with DMS were that such a system exists to prevent accidents caused by tiredness and drowsiness. None of the respondents were aware of inattention detection and dangerous behavior detection. Most respondents indicated that such functionality would perhaps be as interesting as, or even more interesting than, drowsiness detection for many bus companies and haulage contractors. The study found that good communication channels for reaching haulage contractors and bus companies are fairs (e.g. Elmia Lastbil, Load Up North, Vårgårdaträffen, Stockholm Truck Meet, Busstorget and Persontrafikmässan), magazines (e.g. Swedish Haulage Magazine), as well as related digital media channels.

Another result of the study is that many of the respondents are concerned about workers union resistance. This concern has been confirmed as valid by asking Transportarbetareförbundet directly regarding their attitude towards DMS, as well as how they would react if employers try and implement it. According to this study, the transport workers union in Sweden have a negative attitude toward DMS. Transportarbetareförbundet believes there are ulterior motives among employers who want to install DMS in their vehicles.

Lastly, one respondent indicated that DMS will perhaps be the most interesting for a small segment of the haulage industry, rather than the entire industry, seeing that many haulage distances in Sweden are less than 300 km. According to the same respondent, it will be hard to determine whether accidents are prevented as a result of the DMS or some other system or factor. The fastest way to diffuse DMS for a supplier would be to have it originally installed in the vehicle. Most respondents agreed that originally installing a DMS would be the best option, although one respondent was indifferent to installing the system pre- or post-production.

# 6. Conclusions

*What factors do stakeholders along the SAIDMS value chain consider important for adoption?*

This study has found concerns among respondents regarding personal integrity, data collection and data storage, which could be a sign of a perceived incompatibility of the innovation with end-user preferences. This result has been triangulated with both qualitative and quantitative methods in this study. Furthermore, the workers union Transportarbetareförbundet is very skeptical toward DMS, signaling that driver acceptance could be an important factor for the diffusion process.

Cost is another major concern among bus companies and haulage contractors, which state that their customers must be willing to pay for DMS. This emphasizes demand factors as important for the diffusion process. Other factors found important in this study are availability of service and maintenance and the product being finished and functional at the time of adoption.

Haulage contractors and bus companies seem to be in the awareness-knowledge stage of the innovation adoption process, meaning that they know of the existence of DMS, but not much regarding product functionality or usage. When informed by some functions which respondents did not know about, respondents displayed interest in dangerous behavior detection and inattention detection, signaling that increased awareness-knowledge regarding functionality is both possible and potentially beneficial for future adoption decisions. Lastly, this study indicates that the size of the adopting firm matters for the potential interest in DMS adoption.

*What attitudes do future end-users of Driver Monitoring Systems have toward Driver Monitoring?*

The study found that most respondents would feel good or very good about driving a car with a DMS. Almost 10% would feel bad or very bad about driving a car with a DMS. In addition, slightly above half of the respondents would feel safer or much safer if their car had a DMS. Less than five percent of respondents would feel less safe. Almost three fourths of respondents would feel safer if every car had a DMS. Furthermore, almost 70% of the

respondents would rather buy a car with a DMS than without one. Almost one fourth of respondents who have been involved in a traffic accident believe that the accident could have been avoided with a DMS.

Concerns among potential end users are similar to those of the stakeholders along SAIDMS value chain: personal integrity and data-related concerns are the most prominent. Almost one fourth of the total sample of respondents indicated that they have some sort of data-related concerns. However, the answer to the research question is that most respondents have a positive attitude toward Driver Monitoring.

*Which demographic characteristics and experiences can have an effect on future end users' attitudes toward Driver Monitoring Systems?*

The three demographic characteristics and experiences which had a positive and significant effect on attitudes toward Driver Monitoring Systems are being male, having a higher educational level and work requiring one to drive a car. More specifically, being male and more educated has a positive effect on feeling good about driving a car with a DMS installed, whereas work requiring one to drive a car has a positive effect on feeling safer if every car had a DMS. However, all three regression tables and their corresponding models have fairly low Adjusted R Square value, indicating that the explanatory power of the regression models are fairly low. The highest Adjusted R Square value achieved is the one in table 14, namely 0.139, indicating that the independent variables included explains 13.9% of the variance in the dependent variable. Thus, all conclusions derived from these regression models should be interpreted with some caution, as there likely are other explanatory factors at work which could help predict the variance in the dependent variables examined.

*How can Smart Eye influence the rate of diffusion of their product SAIDMS?*

According to this study, the most important actions which could increase the rate of diffusion of SAIDMS are to:

- Increase product acceptance among workers unions and drivers, as resistance among these groups could prolong the sales cycle,
- Focus marketing efforts toward larger haulage contractors,
- Increase knowledge about DMS in general and SAIDMS in particular among haulage contractors and bus companies, focusing on knowledge about inattention detection and dangerous behavior detection,

- Utilize fairs, such as Elmia Lastbil, Load Up North, Vårgårdaträffen, Stockholm Truck Meet, Busstorget and Persontrafikmässan, and magazines, such as Swedish Haulage Magazine, to reach haulage contractors, bus companies, drivers and purchasers of their services,
- If possible, provide both information availability for management of haulage and bus companies in order to increase customer value, and personal integrity-guarding measures in order to increase driver acceptance,
- Retain previous success factors of Smart Eye:
    - Compatibility with different vehicles
    - Good functionality in terms of robustness
    - Small footprint
    - Active relationship building with customers and customers-of-customers

# 7. Discussion

Findings regarding personal integrity, data collection and concerns thereof resembles an indication of uncertainty regarding compatibility (Rogers, 2003) with adopters' previous experiences, values and norms. If one's experiences, values and norms discourage being monitored, personal integrity violation could indeed prove to be a compatibility issue of not only SAIDMS, but DMS in general (and of course other products which are capable of collecting information about the user). In addition, this finding supports Viktorovás & Šuchas (2018) findings regarding driver acceptance as a requirement for benefit delivery, but for the Swedish DMS-market rather than ADAS systems in the Czech Republic. The importance of supply factors is also emphasized, as costs and cost transferability is another major concern. This finding is in line with Cool et al. (1997) and Brown's (1981) critique of the traditional diffusion model, stating that it is focused too much on demand factors and not enough on supply factors. The study contrasts Planings (2014) finding that women are more likely to adopt ADAS, as the study showed a positive effect of being male on feeling good about driving a car with a DMS. One of the industry experts pointed out that DMS technology will likely be interesting for the 15% of the Swedish haulage industry which does not consist of only a truck and a couple of employees, which is in line with factoring in the size of the adopting firm, as Frambach & Schillewaert (2002) emphasized.

The main theoretical building block of the thesis, i.e. the theory of diffusion of innovations (Rogers, 2003), has proved useful in sensitizing me to information which is potentially relevant for the

velocity with which SAIDMS will diffuse. However, the diffusion model encompasses many things, is expressed in a very general way and includes almost anything which could potentially have an effect. As such, most factors that arise can in some fashion be interpreted as “part of the model”, such as personal integrity concerns being a sign of incompatibility with values and norms. As such, I found the model useful as a guidance and framework through which I could view the quantitative and qualitative data gathered in the study, but it did not help in prioritizing and ranking the factors relative importance for the product. It is also hard to criticize the model, as it is so generally applicable. The only thing which arose from the study which was not really emphasized in the diffusion model set forth by Rogers (2003) is the importance of costs and cost transferability.

# 8. Suggestions for future research

Replicating this study in an international setting with not only Swedish potential customers could provide further insights with regard to what factors are important for the diffusion of DMS in general and SAIDMS in particular. Conducting the quantitative study only on commercial drivers could provide more accurate conclusions regarding this particular group of end-users. In addition, asking purchasers of haulage and bus services what could make them interested in choosing suppliers who have adopted DMS could prove useful in a future study.

One area which could require further exploration is personal integrity as a compatibility issue. How do concerns regarding personal integrity and data collection/storage affect the probability of adoption of technologies which collect and store data? This can be measured and could provide an interesting development of the compatibility-factor of the innovation itself which Rogers (2003) found is important for an innovation’s potential diffusion.

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