Aalto University

School of Science

Master's Programme in International Design Business Management

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Factors influencing drivers' acceptance of in-vehicle monitoring

Master's Thesis

Espoo, November 27, 2017

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ABSTRACT OF THE
MASTER´S THESIS

Author: Derek Hsien Wei, Chan

Title of the thesis: Factors influencing drivers' acceptance of in-vehicle monitoring

Number of pages: 89

Date: November 27, 2017

Major or Minor: Major in International Design Business Management

Supervisor: Professor Matti Vartiainen

Thesis advisors: Tanuj Pasupuleti, M.Sc.

This study investigates the influencing factors that affect drivers' acceptance of products or services, that implement in-vehicle monitoring.

The rapid growth of the sharing economy, aided by smartphones, results in many innovative automotive applications from commercial service providers, such as Uber, MaaS or car-sharing applications. However, many projects that try to introduce new business models, using in-vehicle monitoring, ultimately were not received favorably. To investigate the factors, a qualitative analysis and ecosystem approach were used; 19 stakeholders, consisting of regular and professional drivers, as well as automotive-related organisations, unions, transport and research agencies, were interviewed and their inputs were analysed to provide a starting reference of the influencing factors.

The study found that there are 9 factors that influence driver's acceptance of in-vehicle monitoring: (1) Comparing benefits and costs, (2) Privacy, (3) Autonomy of driver, (4) Driver's ideals and morale, (5) Ownership of vehicle, (6) Trust, (7) Design of system, (8) Awareness of technology, and (9) Media and marketing.

Organisations are encouraged to consider these influencing factors when designing their products and services. The study recommends that organisations design products and services that appeals to the drivers' motivation and perspective of what is important to them during their drive. In addition, technical considerations for data privacy, security and trust are presented. Finally, the overall design and marketing recommendations for organisations are presented.

Keywords: driver, acceptance, vehicle, monitoring.

Publishing language: English

Acknowledgements

The journey to complete this thesis has been long and daunting. Combining the thesis work with my start-up work had been immensely challenging, and I had to change my initial topic after the start-up pivoted the product idea. Through all this, I deeply appreciate the patience and understanding of my thesis supervisor, Professor Matti Vartiainen, for his constant support of my work. His advice and feedback have been very motivating for me to continue the work. I want to thank both my thesis instructors, Mr Tanuj Pasupuleti, for helping me to crystallise the topic, as well as Dr. Bert Arnrich, who has given me invaluable input for this effort. My sincere thanks to all the people and companies who have given me their frank input for this study, I appreciate your time given to me. My teammates at Servoped have also been very considerate of the time and space that I needed for this work. Special thanks to my dear friend Osman, who encouraged me to pursue my Masters studies at Aalto University. Lastly, I would like to thank my parents and my partner, Jussi, for being so supportive of me during this work.

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Glossary

ABS	Anti-lock braking system
CAN	Controller Area Network (of a car)
DoI	Diffusion of Innovations
ECU	Electronic computer unit (of a car)
GPS	Global positioning system
IT	Information technology
ITS	Intelligent transport systems
MaaS	Mobility as a Service
MLP	Multi-level perspectives
OBD2	On-board diagnostics (version 2)
SDT	Self-determination theory
TAM	Technology acceptance model
TRA	Theory of reasoned action
UBI	Usage-based insurance

1. Introduction

1.1 Mobility trend as the background

The growth of the sharing economy, largely driven by innovative mobile applications like AirBnB and Uber, has brought about many changes to consumer behaviour in infrastructure ownership and usage. There is a shift to a use of temporary access, non-ownership models of utilising consumer goods and services (Belk, 2014). In the field of transportation, there is a shift in business models from traditional vehicle ownership to a provision of Mobility as a Service (MaaS) (Heikkilä, 2014).

The burden of vehicle ownership is shifting from the individual to the organizations providing the service. Young people are apparently losing their interest in car ownership as being important to their self-definition. They find car purchase, maintenance, and parking to be prohibitively expensive and increasingly would rather not have the hassle of ownership (Belk, 2014). In the traditional model, a sold car is paid immediately by the buyer. In the new model, earnings come gradually by miles and usage hours (Finnish Transport Agency, 2015)

1.1.1 New business opportunities and risks

The mobility trend has benefitted the automotive industry: vehicle leasing has seen a significant rise in business, accounting for nearly one in every three cars manufactured in the United States in 2016 (The Detroit News, 2016). This is boosted with the popularity of ride-hailing apps like Uber. Part of Uber's business model involves leasing cars and assigning cars to its drivers, much like a taxi company. In the United States, Uber created a leasing company, Xchange Leasing, which at one point, registered up to 41% of sales for a car dealership (CNBC, 2016). With more companies

owning fleets of vehicles that are used as a service, there is also an increased risk of monetary loss with their vehicle fleet.

A part of the monetary loss comes from the risk of repair of cars that developed faults from bad driving techniques. In vehicle leasing, two types of lease arrangements are common: closed-end and open-end. In the closed-end leases, the lessee pays a uniform payment for a set term and bears the risk of paying for the repair of the returned car with excessive wear and tear (Brown, 2010). In the open-end leases, the lessee and lessor agree on a depreciation rate of the lease to estimate a residual value at the end of the lease. When the lease ends, the difference between the current market value and residual value, is paid by either the lessee and lessor. The lessor bears the additional risk of getting a car back with excessive wear and tear that needs to be repaired (Brown, 2010).

There is no current system to give an estimate of the value of the car based on its health. At the end of the lease, the bearer of the risk inherits a car that has unknown repair costs. The same risks are borne by car-sharing companies like GoNow. With more companies providing car-sharing services to individuals and corporate clients (Belk, 2014), the frequent turnaround time of usage poses a higher risk to the health and value of the cars owned by these companies.

1.1.2 The connected car

At the same time, car technology has been evolving rapidly. The pervasive use of smartphones and constant connectivity to the Internet, have led vehicle manufacturers to integrate these devices to the in-car dashboards, providing drivers access to a variety of data sources online. With the

smartphones' market gradually saturating, companies like Apple and Google have also turned their attention to the next big thing: the connected car, creating automotive versions of their mobile platforms to provide new value and services to drivers (IoT now, 2015).

The connected car is generally defined as a car that can access the Internet at any time, either using an in-built device or a brought-in device. The connected car offers infotainment features to its users, as well as communicate with other smart devices or cars on the road (Coppola & Morisio, 2016). With an in-built device connected to the ECU of the car, it is also possible to read data from various sensors of the car, previously only accessible to car workshops. This implies that potentially all information on the status of the car can be accessed and transmitted wirelessly over the Internet. The connected car is seen to pave the way forward for the development of the autonomous car, where connectivity, sensor data and machine learning are essential, so that the car can operate autonomously in a dynamic environment (Agrawal & Gulhane , 2017).

The connected car brings about new applications: service providers can provide contextually-aware applications to customers, depending on the location of their car. Transportation companies can handle delivery tasks better by using real-time information of their vehicles in operation. Authorities and traffic agencies can also better manage road usage and flow control, developing innovative solutions to improve transportation.

Connected cars also provide an opportunity to manage the risk of monetary loss from car leasing. By leveraging on tools that read sensor data coming from the car, the health and the impact to the car's value by the drivers can be analysed by software algorithms. Organizations can therefore

benefit from using an in-vehicle monitoring system that monitors, and analyses data related to the car and the driver.

1.2 Purpose of the study

However, challenges exist for organizations to convince drivers to accept using a car that is constantly monitored. The technology push is high but policies and political goals are often confused with the driver's personal goals. Societal goals and individuals' goals do not necessarily coincide (Adell, 2010). User acceptance is usually not considered as one main part in telematics and network performance assessment (Böhm, et al., 2008). There is a need to better understand the behaviour of the drivers and what factors influence them if they accept to get monitored.

As a part of a product development plan of Servoped Oy to develop a vehicle health monitoring system for automotive-related companies, this study focuses on the factors of a driver's acceptance of in-vehicle monitoring system. The learnings from this study will be useful for organizations to prepare a good strategy for a successful customer adoption of in-vehicle monitoring, to reap the benefits of the additional services that they can provide on top of it.

The study aims to answer the following:

Research question 1: What are the factors that influences drivers' acceptance of in-vehicle monitoring?

Research question 2: What do organizations need to consider when introducing in-vehicle monitoring into their products and services?

A research methodology with an ecosystem approach can help to identify the important actors related to the in-vehicle monitoring, to get their inputs that help to answer the research questions.

1.3 The structure of the thesis

This thesis consists of 5 chapters. Chapter 1 provides the background of the motivation behind this thesis study. The chapter explains the various socio-tech-economic trends that drive the need for in-vehicle monitoring and its acceptance, leading to the formation of the research questions.

Chapter 2 details the literature reviews that support the background of the research. The various frameworks from existing literature are analysed and applied to the research. The framework for the research is formed, derived from the learnings of the literature reviews. The learnings from the literature reviews are also used to form an initial list of stakeholders, as well as interview questions.

Chapter 3 details the research design and methods used in this study. The chapter discusses the tools used in data collection and the reasoning behind the tool selection. The selection of the interviewees, their value to this study and the interview questions, are also discussed. Interviews are then conducted based on the research framework.

Chapter 4 shows the results of the information collected from the research interviews. The collected data from the research method is analysed to answer the main research questions.

Chapter 5 discusses the results of the study. Implications of the results are discussed and areas for follow-up study are recommended. The chapter concludes the thesis.

2. Theoretical background

This chapter describes the theoretical foundation that the study will be based on. We examine research papers on different aspects of in-vehicle monitoring, as well as popular acceptance theories. Thereafter, we will consolidate the various theories to form a research framework, to start the data-collection. We begin by examining studies done on the keywords in the title: “In-vehicle monitoring”, “Acceptance” and “Drivers (Stakeholders)”.

2.1 In-vehicle monitoring

The On-Board Diagnostics (OBD2) is a physical port and automotive industry standard that allows reading of data from the car’s electronic computer unit (ECU). The OBD2 port has traditionally been used by car technicians to read diagnostic trouble codes so that they can service the cars effectively. By collecting data from the car’s ECU via OBD2, useful auxiliary information can be extracted and learnt. For example, the EU uses it to assist in the implementation of vehicle emissions testing programs (European Parliament, 2007). Many current in-vehicle monitoring devices make use of OBD2 technology to read and analyse data coming from the various sensors in the car.

For this study, we define in-vehicle monitoring to be a tool, or application inside the vehicle, that collects and processes information about the vehicle and drivers, or passengers, to provide a certain feature, such as a service, safety warning or feedback to the driver, etc…

2.1.1 Types of in-vehicle monitoring

In-vehicle monitoring technologies have been used extensively, especially in professional driving industries. In a paper examining truck drivers' attitudes towards feedback by technology (Roetting, et al., 2003), a summary of in-vehicle monitoring systems used in the trucking industry is provided (Table 1).

Table 1: Types of in-vehicle monitoring systems

Type	**Purpose**	**Usage category**
Collision avoidance / warning system	Detection and warning of obstacles ahead of vehicle.	Safety alert
Adaptive cruise control	Maintain separation of distance to the vehicle in front.	
Rollover detection and prevention system	Alerts driver if speed is exceeded that may cause a roll-over.	
Lane tracking / departure system	Alerts driver if vehicle veers off the lane markings.	
Side sensing devices	Monitors the sides of the vehicle to prevent side-swipe crashes.	
Driver alertness monitors	Monitors driver's eyelids or steering wheel position to check if it is out of driver's benchmark for alertness.	
Vehicle and cargo tracking systems	Tracks location of vehicle using GPS.	Driver performance tracking
In-vehicle event data recorder ("black box")	Record vehicle performance, including belt usage, driver's steering, ABS, speed, and location of vehicles.	

When we categorise the usage of in-vehicle monitoring, it is seen that many in-vehicle monitoring systems are used as a safety alert to drivers, with only some systems functioning as a driver performance tracker for companies. Many of these in-vehicle monitoring technologies from the professional driving industry are now also used in consumer cars. It is interesting to understand from the drivers on what their perception of an in-vehicle monitoring system is and what their expectation of the system is.

In-vehicle monitoring systems can either be obtrusive or unobtrusive, known or unknown to the driver. Some vehicle manufacturers now incorporate silent monitoring systems into their vehicles. Tesla vehicles are constantly connected to the manufacturer via the Internet, without being seen or known to the drivers (Simonite, 2016), while some professional transportation companies, such as haulage trucks or buses, implement monitoring devices that their drivers must conform to, when performing their jobs.

2.1.2 Challenges to in-vehicle monitoring

The EU parliament passed laws in 2015 that makes it mandatory for all new cars and light commercial vehicles to pre-install eCall, an in-vehicle monitoring device, by April 2018 (European Parliament , 2015). These devices primarily serve as incident recorders that triggers an emergency phone number-112 notification when the car gets into an accident, providing the car's location and identification data to emergency services (European Commission, 2015). The eCall system claims to cut emergency response time by up to 50%, thus saving more lives in the EU (European Commission, 2016).

While the eCall system has a noble purpose to save lives, it has raised issues of data privacy infringement among EU citizens. Citizens are concerned that their location will be constantly tracked, driving habits monitored and private lives infringed. The eCall project responded by assuring citizens that the project is protected under European privacy laws and the collected data set is minimal and triggered only in the event of an accident (European Commission, 2014). It is interesting to note that the eCall project supports the use of third-party providers of a similar service but does not mandate a default privacy protection when third party services are used.

The introduction of an eCall-like "black box" by the Finnish government, has also been faced with public resistance. The Finnish transport ministry proposed to use the in-vehicle monitoring system for tax-collection on road usage, to improve road maintenance. There was a big public debate on the security of the system and the privacy of the collected data (Uusi Suomi, 2017). Negative opinion pieces with titles like "Peto pääsi irti... (translated: the beast is out)" and "Karmea tietoturvamoka mustissa laatikossa… (translated: spooky security black boxes)" are written by both journalists (Tamminen, 2017) and political opponents (Paalijärvi, 2017).

It may be presumptuous to make a judgement that data privacy is the main reason for resistance. From a brief thematic analysis of readers' comments to 3 opinion articles on the "black-box" topic in Uusi Suomi (Tamminen, 2017; Paalijärvi, 2017; Ovaskainen, 2017), it is observed that besides data privacy, the readers are also concerned about financial implications to them, how their tax money is used and the honesty of the government/organization using the data. The attitude of the readers' comments has political tones, with little objective view of the benefits of such a

monitoring application. The challenge to introduce mandatory in-vehicle monitoring in Finland is complex, with potential political backlash.

Voluntary in-vehicle monitoring also faces challenges: automotive insurance companies offer new products like Usage Based Insurance (UBI) that is tailored to the individual driver. The driver's smartphone is used as a tool that helps monitor driving behaviour and provides data to companies on how the driver is driving, to assess his risk, and ultimately his insurance premiums. From a discussion with a representative of a reputable finance company in Finland, he informed that UBI has been in pilot study for 6 years but is still yet to launch. The representative feedback that it is challenging to convince drivers to use in-vehicle monitoring for a variable insurance premium. A bad driver feels he is being penalized while a good driver may have no real incentives to use it, since there is already a discount system normally in place for no-claims rewards. UBI has seen some successes in countries like Britain but remains a niche product.

In-vehicle monitoring remains a controversial technology that divides the driver population and the organisations that want to implement it. By considering acceptance theories and past learnings in the next chapter, we can attempt to identify factors that influence the general acceptance.

2.2 Theories impacting acceptance and behavioural change

In Intelligent transport systems (ITS) research, the definition of 'acceptance' is usually taken for granted and most researchers assess acceptance without defining it (Adell, 2010). To define 'acceptance' for this study, we first study several theories of acceptance and behavioural change,

including learnings from selected research papers and projects, to assess how they relate to in-vehicle monitoring systems.

2.2.1 Diffusion of Innovations

The Diffusion of Innovations (DoI) (Rogers, 1995) is a well-known theory that describes the factors concerning the rate that new ideas and innovations spread. The theory has been used across in researches across many disciplines. According to DoI, there are four main elements in the diffusion of innovations: the innovation, the communication channel, time, and the social system. With innovation, the rate of diffusion is affected by the following factors in Table 2. We analyse the relevance of each factor to this study, to formulate appropriate questions.

Table 2: Factors affecting rate of diffusion in DOI

Factor	**Definition** (Rogers, 1995)	**Questions for this study**
Relative advantage	The degree which the innovation is seen to be superior to its predecessor.	What was the previous driving experience of the driver, before the in-vehicle monitoring? Has the monitoring enhance or hindered the experience?
Complexity	The degree which the innovation is seen to be relatively difficult to use and understand.	What is the experience of the driver in using the in-vehicle monitoring system?
Compatibility	The degree which the innovation is seen to be compatible with the user's values, beliefs and needs.	What user needs are being fulfilled by the in-vehicle monitoring system and what are the driver's beliefs towards it?
Trialability	The degree which an idea can be experimented.	How flexible is the in-vehicle monitoring system?
Observability	The degree which the results of the innovation are visible.	What are the clear benefits of using the in-vehicle monitoring system?

DoI defines communication channel as the means by which knowledge or experience of using an innovation is spread from one user to another (Rogers, 1995), and the mass media is the most rapid and effective channel to do so. Communication channel is important, as DoI argues that most people depend mainly on a subjective evaluation of the innovation that is conveyed to them from other individuals who have used the innovation. Communication is most effective between homophilous people (people with similar origin and situation), because they speak the "same" language. However, DoI usually require communication between heterophilous people, of which the "change agent" usually has the knowledge to diffuse to the other. It is therefore important to consider the ability and behaviour of the stakeholders, for effective impact of the marketing communication of the in-vehicle monitoring system to drivers.

Time in DoI affects three factors: (1) the innovation-decision process, (2) the level of innovativeness/adopters and (3) the rate of adoption. With the innovation-decision process, time defines the period of which a user goes from gaining knowledge and being persuaded on the innovation, to making an acceptance decision, implementing the innovation and finally reinforcing his/her earlier decision. We can relate the spread of knowledge and persuasion of the user, to branding concepts. Time also measures the level of innovativeness of the adopter of the innovation. If a person chooses to adopt the innovation early, he is more likely to have higher social standings, use more mass media channels and spread new ideas to others. Finally, the rate of adoption measures the time period required by a certain percentage of members of the system to adopt the innovation (Rogers, 1995), forming the critical mass. The time factor in DoI provides insights to the type and influence of stakeholders that we should consider in the branding and marketing of the innovation.

Social system in DoI describes the inter-connected units of individuals and groups that are united in problem-solving, to achieve a common goal. The social system has various structures that provide stability and can either facilitate or impede the diffusion of innovation. The norms of a social system are established behaviour patterns that are hard to change. We can see an example of this with the news of an advance surveillance system being used in Singapore for unfettered intelligence tapping. The news gained little traction among citizens and the writer opined that Singaporeans are "more concerned about moral policing than the possibility of having their actions being monitored by the state." (Lee, 2013). Social systems also consider stakeholders with different levels of influences on others, as well as the different types of innovation-decisions made by individuals. This can range from independent decisions, to collective decisions, to top-down authority decisions, to sequential (dependent) decisions. With in-vehicle monitoring, we can consider the different types of innovation-decisions in effect: Governments that want monitoring data to implement new services (top-down); Companies with new business models that seek collective acceptance from drivers; Drivers who make independent decisions but may see previous successes from companies, before making decisions (sequential). The SAVE project study (Petica & Bekiaris, 1996) stated that people may not always know their needs before an innovation is introduced. They will be tempted to try it or even accept it, and new needs may develop as a result. Finally, the positive (or negative) consequences of the adopting an innovation also affects its diffusion.

2.2.2 Technology acceptance model

The technology acceptance model (TAM) is probably the most well-known among the different models and frameworks concerning user acceptance and IT. The model states that the user's behavioural intent to use a specific technology is impacted by his/her perceived usefulness and perceived ease of use of that technology (Figure 1). These two perceptions are influenced by external factors that shape the user's attitude towards using the technology (Davis, et al., 1989).

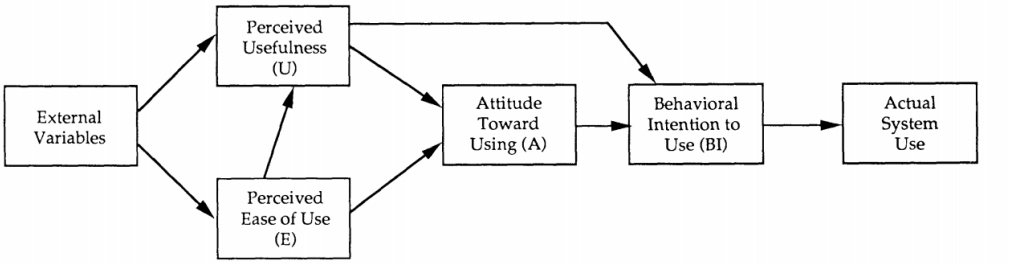

Figure 1: Technology Acceptance Model (Davis, et al., 1989, p.985)

Perceived usefulness is the subjective feeling of the user that using the technology will increase his job performance. This perception is above any positive or negative feelings that arise from the use of the technology. Davis, et al. (1989) described that people form a general perception of usefulness very quickly after using a system for a short time and this impression is significantly linked to the future acceptance of the system. However, in a study to determine if teenage driving behaviour improves when in-vehicle monitoring is used (Farmer, et al., 2010) , the results showed that although the teenagers in the study were annoyed by the system, they felt that it made them drive better. Adell (2009) proposed that there are different degrees of acceptance of driver support system, and that a driver does not have to like to use the system to demonstrate acceptance. It is

enough that he 'tolerates' the use. It is interesting to compare the driver's early impression and his follow-up perception of the usefulness of the system.

In the context of in-vehicle monitoring, for example, perceived usefulness can be a driver's reaction to an in-vehicle feedback system that reminds him to drive safely. A study on truck drivers' attitudes towards feedback by technology shows that drivers expect an increase in their driving performance and efficiency from using such a feedback system (Roetting, et al., 2003). A similar study on in-vehicle data recorders for monitoring and feedback on drivers' behaviour (Toledo , et al., 2008) shows that while the feedback does reduce the risk of drivers' crash over time and impact their behaviour, there is a lack of study on the psychological and sociological mechanisms that support driving behaviour change via in-vehicle monitoring. The external factors affecting perceived usefulness, especially psychological and sociological factors, are interesting to this study.

Perceived ease of use is the perception of the user, that using the technology will involve minimal effort. TAM describes two mechanisms by which perceived ease of use affects acceptance: self-efficacy and instrumentality. The higher the perceived use-of-use, the greater the user's sense of self-efficacy and personal control (instrumentality). This has interesting implications when we relate it to motivation theories later in this chapter.

The impact of perceived ease of use is somewhat ambiguous in TAM: a study on truck drivers' attitudes towards monitoring and feedback showed that perceived ease of use is insignificant towards the driver's intention to use (Ghazizadeh, et al., 2012) while a study on citizens' utilization of e-government resources concludes that perceived ease of use is important, especially across the

age range and expertise of the users (Carter & Bélanger, 2005). To consider perceived ease of use for this study, we should apply it to a reasonably wide range of drivers with different requirements and experience towards using in-vehicle monitoring technology. It also depends on the complexity of the interaction needed (if any) between the in-vehicle monitoring system and the driver.

Chen and Chen (2011) applied the TAM to traveller's usage intentions of GPS devices and added two other factors: perceived enjoyment and personal innovativeness, into the model. Perceived enjoyment was applied in consideration of the entertainment feature of the GPS device. For an in-vehicle monitoring system, perceived enjoyment may be applicable if the driver enjoys the experience of driving through the features of the system. For example, this can be in the form of a game or simply information that provides for a more enjoyable drive. Personal innovativeness involves the willingness of the user to try out any new technology. Chen and Chen (2011) concluded that, in addition to perceived ease of use and perceived usefulness, perceived enjoyment and personal innovativeness have significant, positive effect on the user's attitude that determines the intention to use the device. It is therefore interesting to include these two factors in this study.

2.2.3 Theory of reasoned action

While TAM is applied and tested in many studies, its primary relevance is in the use of computer systems in organizations. TAM is adapted from the Theory of Reasoned Action (TRA) and it defines two beliefs: perceived usefulness and perceived ease-of-use, as being primarily relevant for computer usage acceptance.

In evaluating acceptance of in-vehicle monitoring, we also need to consider that the monitored information may be mandated and used by others, besides the driver. Therefore, the beliefs of the driver on how the information is used and the consequence of using the in-vehicle monitoring system, should be considered. In this aspect, the TRA offers a more general consideration of the user's beliefs that impact his attitude to use in-vehicle monitoring (Figure 2), and is therefore useful in this study.

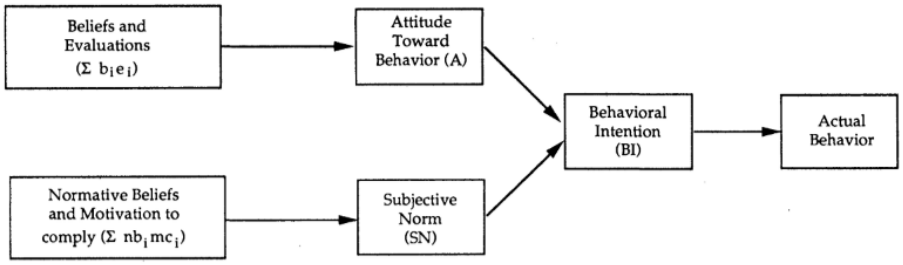

Figure 2: Theory of Reasoned Action (Davis, et al., 1989, p.984)

TAM also does not consider subjective norm as one of its determinant of a user's intention to use a technology. Subjective norm is the user's perception of the specific expectation of relevant people or groups. In a paper comparing TAM to TRA, the researchers stated that subjective norms may influence the user's attitude either through an identification or compliance to other individual or groups (Davis, et al., 1989). The study on the effect of monitoring on teenage driving (Farmer, et al., 2010) showed that a combination of in-vehicle alerts to the teenage drivers and simultaneous notifications to parents worked best. Parents are important influencers to make in-vehicle monitoring effective in changing the driving behaviour of their teenagers, but it is not clear how to encourage their participation.

In considering acceptance of in-vehicle monitoring, social influence by important stakeholders to the driver should be considered. The motivation of the driver to comply to the social expectation, and the motivation behind their social influencers should be studied. The user's beliefs and subjective norms (social impact) described by TRA are also relevant to the study and should be applied, in addition to the TAM.

2.2.4 Motivation and the self-determination theory

TAM and TRA both describe that rewards and external stimuli may not directly affect the attitude of the user to impact on the acceptance behaviour. However, it acknowledges that positively valued outcome does increase one's affect to achieve the outcome (Davis, et al., 1989). It is therefore worthwhile to consider the motivation of the drivers towards the acceptance of the in-vehicle monitoring.

In a paper studying intrinsic and extrinsic motivations, the authors stated that, in addition to the level of motivation, the orientation of the motivation (the type of motivation) must also be considered, (Ryan & Deci, 2000). There are three overall types of motivation, from amotivation, to extrinsic motivation of which a person does something because it leads to an outcome, to intrinsic motivation of which a person does something because it is inherently enjoyable.

The self-determination theory (SDT) expands on extrinsic motivations and described that extrinsic motivations involve instrumentalities that on one hand, give people a sense of volition to endorse the extrinsic goal. On the other hand, it also compels people to comply with an external control (Figure 3). It argues that there is a need to consider the basic human psychological needs of

competence, autonomy and relatedness (Ryan & Deci, 2012). SDT maintains that it is more important to understand whether people's motivation is more autonomous or more self-controlled, than the overall intensity of the motivation.

The embedded social context of the person also plays an important influence on intrinsic motivation and the feeling of autonomy. SDT defines two social contexts; (1) proximal context, where the behaviour of the people around the person plays an important role, and (2) distal context, where the cultural norms and economic structure of the society plays a big role (Ryan & Deci, 2012).

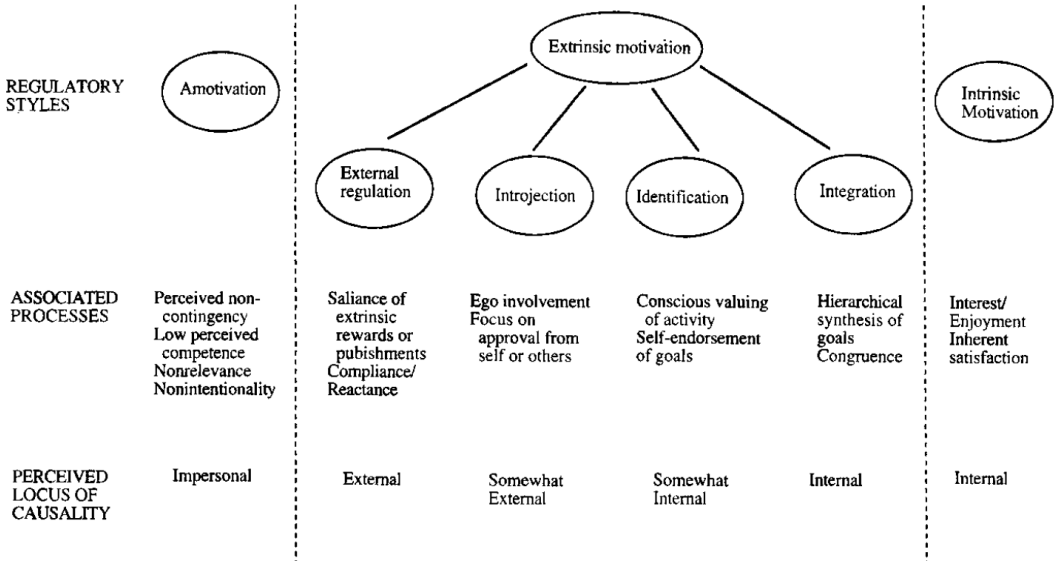

Figure 3: Different levels of motivation in the Self-determination theory (Ryan & Deci, 2012, p.61)

We can deduce interesting relations from SDT to the framework posited by TAM and TRA. The orientation of the motivation posited by the SDT can be related to the attitudes and goals of the users, posited by TAM. The social contexts posited by SDT can be related to the subjective norms

of the TRA and provide a picture of the motivation behind the person that affects his behavioural intent to use technology. SDT's consideration of autonomy can also be related to the ease-of-use's provision of instrumentality to users in TAM.

2.2.5 Trust, privacy and augmenting the Technology Acceptance Model

In a study done on the acceptance of an on-board monitoring system (OBMS) by truck drivers (Ghazizadeh, et al., 2012), the researchers primarily used the TAM as a framework for evaluation. The result showed that apart from perceived usefulness, trust was a major determinant for the intention to use and is a useful augmentation to the TAM (Figure 4).

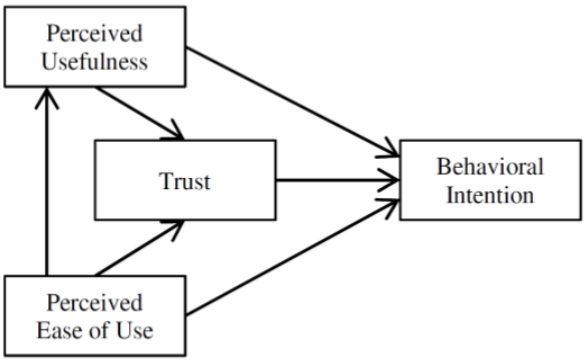

Figure 4: Technology Acceptance Model augmented with Trust (Ghazizadeh, et al., 2012, p.2287)

Trust, or trustworthiness, is generally defined as the perception of confidence in the reliability and integrity of the subject concerned (Belanger, et al., 2002). Ghazizadeh et al. (2012) proposed that the level of trust an individual placed on automation determines the acceptance of the system and argued that the most studies on trust only consider the provider rather than the technology. It should be noted that the OBMS study concerns the acceptance of a safety tracking device in the truck, and therefore the trust is on the device to work properly so that the driver's safety is guaranteed.

For an in-vehicle monitoring system, we need to consider trust in both the service provider and the technology. According to McKnight, et al. (2002), initial trust refers to the 'trust in an unfamiliar trustee, a relationship in which the actors do not yet have credible, meaningful information about, or affective bonds with, each other'. When the service provider and technology is unknown to the user, the initial trust in the service provider depend on 'whatever information people has, to make trust inferences' (McKnight, et al., 2002). This can be, for example, the perceived role and reputation of the service provider, whether it is governmental or a private organisation, and how the collected information is perceived to be used. A national survey on e- government services, conducted on United States (U.S.) citizens in 2001 showed that while U.S. citizens believed that e-government has potential to improve things, they have concerns about sharing personal information with the government over the internet, fearing that the data may be misused, and privacy will be diminished (Carter & Bélanger, 2005). McKnight et al. (2002) described that certain factors affect the individual's perception in institution-based trust: the presence of structural assurances that provide protection and regulations, as well as situational normality that provides an environment with a competent vendor who has integrity. Ghazizadeh et al. (2012) reflected that trust is a dynamic belief that evolves over time, just like acceptance that is not constant (Kim & Malhotra, 2003). In this respect, we should consider how trust can be managed by the service providers, to maintain the level of acceptance over time. The factors influencing the perceptions and beliefs of the user towards the service provider are interesting to investigate.

Carter and Bélanger (2005) showed that privacy and security are reoccurring issues in e-commerce and e-government research. When we consider the trust in the technology of the in-vehicle monitoring system in the context of privacy, we should determine whether the system is collecting

accurate data and whether the processing of the data is secure, including the transmission to the internet.

2.2.6 User control

User control is emphasised across several theories: SDT's consideration of autonomy and TAM's ease-of-use's provision of instrumentality to users, are all variations of providing some degree of control to the user. The emphasis on user control is also seen in the development of MyData, a Finnish framework for the utilisation of personal data that gives each person opportunity to decide which firm, service or apps may use his personal information. The operation model of MyData is seen as a powerful tool to increase user acceptance towards new innovations (Moving Forward Consulting, 2016).

Carter and Bélanger (2005) stated that voluntariness (control) is an additional factor influencing the acceptance and use of an innovation. The SAVE project showed that the monitoring concept was generally accepted by users and key stakeholders (Petica & Bekiaris, 1996). The system required no intervention on the user's side, and authorities had no access to the data. The main reservation was that the users preferred that the automatic driving system activates only if they do not react, that is, if they lost control. The key learnings from the SAVE project are adapted to form interview questions for this study (Table 3).

Table 3: Key learnings from SAVE project

	Learnings	**Questions for this study**
1	Ease-of-use of the monitoring system is important and there should be minimal modification to the current usage of the car by the driver.	How much user control should be given versus ease-of-use?
2	The data collected by the monitoring system should not be transmitted to agencies that are undesired by the user.	What stakeholders are acceptable by the user to access their data?
3	Control is important to the user, unless they are somehow incapacitated.	How does the driver want to control in-vehicle monitoring?

2.2.7 Feedback from in-vehicle monitoring

Roetting et al. (2003) conducted a study on truck drivers that is focused on feedback to drivers, provided by an in-vehicle monitoring technology. Considering that most of the feedback is in the form of safety alert, it is reasonable to assume that the truck drivers are receptive to these technologies that protect them while doing their job. Moreover, the truck drivers have little influence over the use of in-vehicle monitoring, since it is part of their job to accept to be monitored. The key learnings of the truck driver study are listed in Table 4 and are adapted to form relevant interview questions for this study.

Table 4: Key learnings from Roetting et al. 2003

	Learnings	**Questions for this study**
1	The demands of a truck driver's job are not well understood by their superiors. Planned delivery schedules are sometimes unachievable.	How can in-vehicle monitoring help drivers to do their tasks better?
2	Truck drivers want feedback on their driving performance but do not receive enough of it. They prefer positive feedback from respected personnel.	What type of feedback from in-vehicle monitoring do drivers want?
3	Rewards need to be meaningful to the truck drivers. There are too many punishments and not enough rewards.	What type of rewards are meaningful to the drivers?
4	Technologies to monitor the physical conditions of the truck drivers were most frequently mentioned.	How do drivers prefer to use in-vehicle monitoring?
5	Data can be used to vindicate the truck drivers in event of a crash.	How should the monitored data be used?
6	Truck drivers feel threatened by the misuse of their driving performance data. Data privacy, over-reliance on technology over good-driving were highlighted.	What are the concerns of drivers over the use of their driving performance data?
7	The feedback delivery source (human vs machine), mode (sound vs visual) and timing (real time vs on-demand) affect its effectiveness.	How should in-vehicle monitoring interact with drivers?
8	All levels in commercial fleets need to be involved when designing a program using in-vehicle monitoring, especially the truck drivers.	Who are the relevant stakeholders in the ecosystem for drivers?

From the different theories concerning user acceptance of technology, it is evident that we must use an ecosystem approach to consider the relationship between the different stakeholders in in-vehicle monitoring. The individual is not sufficient to sustain an acceptance of in-vehicle monitoring; it must be supported by a wider network of other actors, such as organisations, policies and business models. The next chapter describes the various stakeholders and ecosystem that we should consider in this study.

2.3 Stakeholders and ecosystem

The SAVE project is a transport telematics EU research that ran from 1996 to 1998. The project is concerned with the implementation of in-vehicle monitoring system that identifies driver impairment due to a variety of factors such as alcohol use, sudden health issues or drowsiness. The project has done extensive user research with a wide range of stakeholders to investigate driver's needs and public acceptance of emergency control aids inside the vehicle. The SAVE project is a precursor to the eCall system that will be implemented EU-wide in 2018.

In the project report (Petica & Bekiaris, 1996), the key stakeholders are listed in Table 5. The study was concerned with two main groups of drivers: the private car drivers and the professional drivers. The stakeholder list is used as a reference for this study and we expand it to include other important stakeholders, and then justify why they are relevant.

Table 5: Analysis of stakeholders

	Group	Stakeholder	Selected for this study	Reason
1	Private car drivers	Newly licensed drivers	No	Study is not focused on safety issues due to inexperience in driving.
2		Young drivers (< 30 years)	Yes	Interesting group to study: (1) Data privacy-savviness may result in resistance against monitoring (2) Economic interest by companies due to growing spending power.
		Mainstream drivers	Yes	Interesting group to study: (1) Economic interest by companies due to mature spending power.
3		Elderly drivers (> 60 years)	No	Study is not concerned with safety issues due to driving impairment from old age.
4		Disabled drivers	No	Study is not concerned with accessibility or safety issues due to disability.
5	Professional drivers	Long distance drivers (Trucks/lorries)	Yes	Interesting group from driver performance tracking perspective.
6		Short distance drivers (Bus/taxis)	Yes	
7		Race drivers	No	In-vehicle monitoring is already part of the set-up for professional race drivers.
8	Civil agencies	Police / Medical	No	Drivers performance is measured by other means, no commercial interests.
9		Driving authorities	Yes	Interesting group that may enforce guidelines for in-vehicle monitoring.
10		Legislative authorities	Yes	Interesting group that sets the law that supports/oppose in-vehicle monitoring
11		Political parties	Yes	Interesting group that may support or oppose the vehicle monitoring policies.
12		Drivers' unions	Yes	
13	Commercial organizations	Insurance companies	Yes	Interesting group with commercial interests for in-vehicle monitoring.
14		Car-rental/leasing companies	Yes	
15		Car-sharing companies	Yes	
16		Taxi companies	Yes	Interesting group with interests in driver performance tracking.

17		Media	Yes	Interesting group that can advocate or oppose in-vehicle monitoring.
18	Secondary stakeholders	Family and friends of drivers	Yes	Interesting group that may influence driver's decision to be monitored

2.3.1 Multi-level perspectives model

In his study on the process of transitioning to low-carbon transport, researcher Frank Geels applied the multi-level perspective (MLP) onto the analysis of the transitions. MLP postulates that transitions (or change) are non-linear processes that result from the interplay of multiple developments at three analytical levels: niches, social-technical regimes and socio-technical landscapes (Geels, 2012). The levels in MLP are configurations of different actors, with increasing stability from niches to socio-technical landscapes (Figure 5).

The actors at the niche level work on radical innovation that is different from that used by actors in the regime level. It is difficult for the innovation to break through, because the regime level is stabilised with many lock-in mechanisms. Kemp et al. (1998) described three social processes within the niche level: (1) Learning processes that cover a wide dimension; from technological challenge, to the user behaviour and policies. (2) Articulation of expectations and visions to provide guidance on the innovation activity, while attracting other actors with the vision. (3) Building of social network and enrolment of more actors to expand the base. Geels (2012) argued that niches gain momentum when the vision and expectation become more precise and accepted, when the learning processes are aligned and when social networks become bigger, especially if more influential actors join the network.

In MLP, a socio-technical system is formed when existing technologies, user patterns, regulations, infrastructure and cultural discourses are aligned (Geels, 2004). Actors in a socio-technical system are embedded in regimes, which constrain the actor behaviour with rules that cannot be easily changed by individual action. Thus, innovation in regimes are mostly incremental because of these lock-in mechanisms. When we analyse the socio-technical regime level, besides the rules, it is important to investigate the deep structure behind the activities of the actors. Actors in the socio-technical regime level consists of not only those directly related to the technology, but also social groups such as policy makers and civil-society actors.

Finally, the socio-technical landscape is the wider context that influences the niche and regime levels. It is the highest level of structuration, in the form of values, beliefs and ideologies, which cannot be easily changed or controlled by individual actor, and therefore the most stable. If a radical innovation from the niche level manages to break through to the landscape level, then it is successfully adopted for the long-term. The MLP model is useful to map the ecosystem of relevant stakeholders into the different levels, showing their relationships to each other.

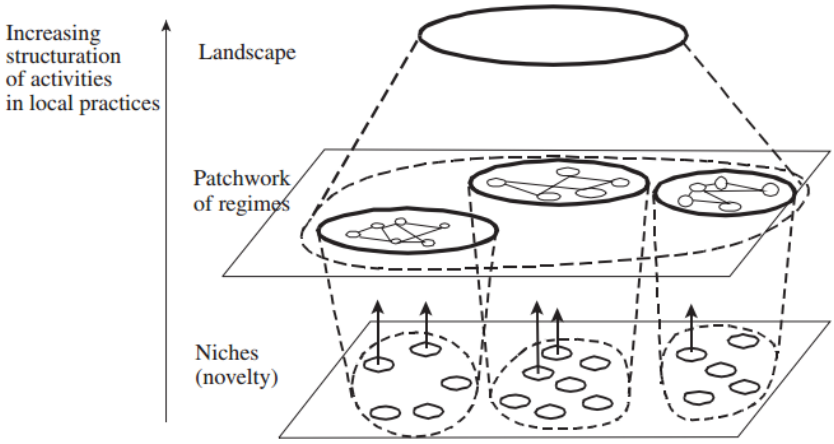

Figure 5: Multiple-level perspectives model (MLP) (Geels, 2012, p.473)

When we apply the MLP to in-vehicle monitoring, organisations and companies which want to implement products/services with in-vehicle monitoring, fits into the niche level. These organisations are constantly learning about the different aspects of in-vehicle monitoring to make products and services with a higher chance of adoption.

Drivers, both regular and professional, as well as drivers' unions are suitable to be positioned on the stable socio-technical regime level. In-vehicle monitoring is still a novelty innovation that is unstable and not likely to be accepted readily by the drivers in the socio-technical regime level. Other stakeholders who have a close influence on the drivers, for example their friends, families and colleagues, as well as driving authorities that are looking after the support infrastructure and welfare of the drivers, are also placed in the regime level, since they are likely to share similar views to the drivers.

The landscape level consists of existing trends, beliefs and policies towards in-vehicle monitoring, which influence the regime and niche levels. Actors in the landscape level set the vision and trends of in-vehicle monitoring, and they are fixed and not changeable in the short-term. We can include stakeholders concerning current legislative, political and popular views in the landscape level, as well as technology providers such as vehicle manufacturers, who set the landscape for technology. MLP is a good overall approach to map out the relevant actors in the in-vehicle monitoring ecosystem.

2.3.2 Introducing changes: acceptance and branding

Banister argued in his study on sustainable mobility, that public acceptance drives political acceptability. There needs to be enough public support for change and then action will take place (Banister, 2008). There is user expectation that any policy being proposed will work and will be fair and efficient. He argued that the real change only comes when the users are actively involved and consulted. However, he warns against using too much incentives to drive acceptability, as it may reduce the effectiveness of the policy. A risky balance must be struck between the desired scheme and accepted scheme. In implementation, Bannister proposed introducing incremental changes to a basic scheme until the policy reaches the final goal. The users need to be informed proactively and made aware of different alternatives. The process of trust-building between the stakeholders must be facilitated by communication and active involvement. The study presents a seven-steps framework to promote sustainable mobility (Table 6).

Table 6: Banister's communication framework

Step	Action
1	Information.
2	Involvement and communication.
3	Packaging.
4	Selling the benefits.
5	Adopt controversial policies in stages.
6	Consistency between different measures and policy sector.
7	Adaptability.

The introduction of a radical innovation requires it to be supported by effective branding to the stakeholders, to drive its acceptance among the users. In his book (Holt, 2004) , Holt argues the successful brands, that became icons in the consumer world, operate at the cultural level. These brands offer myths that relieves the target audience of contradictions present in the society, for

example, anxiety about a big-brother surveillance state. Holt defines a populist world with narratives of which such myths are generated.

Holt describes three interdependent customer segment types that companies need to understand (Figure 6): (1) Insiders advocate the brand to connect it to the populist world. They are intrinsically motivated to participate in activities related to the brand. They have a dedicated and intimate relationship with the populist world and resists its commercialisation. (2) Followers identify strongly with the brand's myth. They constantly assert the quality of their relationship with the brand and its myths and have a paternalistic relationship with the brand. Thus, brands must constantly assert cultural leadership to maintain loyalty. (3) Feeders have superficial connection to the values of the brand's myth. They feed off the identity values of the brand to build their social standings and follow trends, often influenced by their friends. Feeders frequently use language and attitude provided by the brand's myth. Holt maintains that a small group of insiders can have a powerful influence on mainstream followers, who may influence a massive group of feeders towards the brand's identity. Holt's branding model may be applied to in-vehicle monitoring, identifying the role of the different stakeholders and analysing their influence on each other, to deliver appropriate branding messages to drivers.

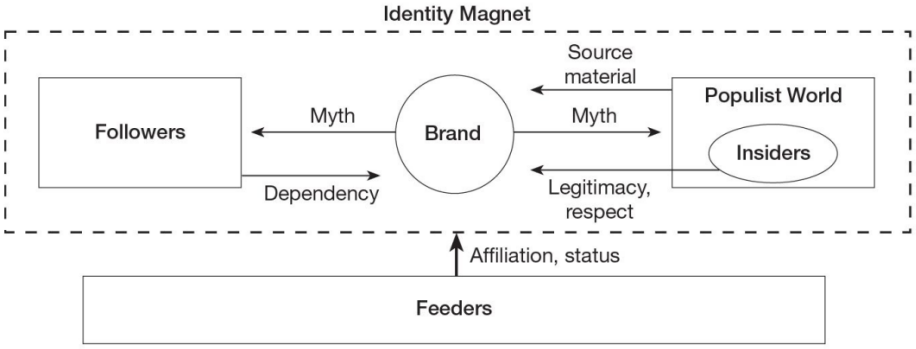

Figure 6: Holt's branding model (Holt, 2004, p.168)

In the next chapter, we compare the various theories discussed so far and formulate a unified framework to generate detailed research questions.

2.4 Research frame of the study

Much research on acceptance of in-vehicle monitoring are mostly concerned with driver safety and prevention of traffic accidents (Böhm, et al., 2008; Roetting, et al., 2003; Adell, 2009). Few studies have been done to investigate how drivers react to performance monitoring of their drive, or how drivers may be influence by new business models from companies, or methods to improve their driving performance.

2.4.1 Definition of drivers' acceptance

Toledo et al. (2008) investigated the potential of in-vehicle data recorders to provide feedback to drivers and change their driving behaviour over time. The results showed that while there was improvement in the driver's risk indices of crashes after getting feedback from in-vehicle monitoring, the improvement diminished over a longer period. It raises the question of whether in-vehicle monitoring systems are effective in improving driver's behaviour, if the change of driving behaviour is not sustainable. Kim and Malhotra (2003) argued that acceptance changes over time and the TAM seems to hold true only for initial use. There is a need to better explain continued use, which requires studies on mechanisms other than those that TAM originally predicates.

For this study, we define driver's acceptance of in-vehicle monitoring to be the continuous use of an in-vehicle monitoring system known to the driver, even if the driver is only tolerating the use

of it. We include drivers' acceptance of in-vehicle monitoring that are not only for driver's safety, but also for performance tracking or for commercial interests from companies and organisation.

2.4.2 Research framework

The earlier literature reviews described the different theories concerning user acceptance and we have discussed the relevancy and inadequacy of each theory, with regards to in-vehicle monitoring. This form the below categories that we define to facilitate the selection of the research theories and thereafter, the formulation of the questions for the data collection:

(1) **Acceptance theory.** The theory involves studying user acceptance of an innovation or technology.

(2) **Sociological factors**. The theory involves social and psychological factors that may affect user acceptance of an innovation.

(3) **Ecosystem level**. The theory uses an ecosystem approach to consider the different stakeholders who may be involved in user acceptance.

(4) **Branding and communication**. The theory involves branding and communication methods as being important to encourage user acceptance.

A summary of the discussed frameworks and their relevance to this study is presented in Table 7.

Table 7: Review and selection of theories

Theory	Focus and limitations	Categories				Selected for this study	Citation
		Acceptance theory	Sociological factors	Ecosystem level	Branding and communication		
Diffusion of innovation	• A comprehensive framework that considers all major factors in user acceptance. • Lack details in implementation of each factor.	X	X	X	X	Yes	(Rogers, 1995)
Technology acceptance model	• Focuses on usefulness and ease-of-use in user acceptance of technology. • Does not consider social and psychological factors	X				No	(Davis, et al., 1989)
Technology acceptance model with Trust	Augments trust into the technology acceptance model.	X	X			Yes	(Ghazizadeh, et al., 2012)
Theory of Reasoned Action	Includes social beliefs as part of what shapes a user's action.		X			No	(Davis, et al., 1989)
Self-determination theory	Considers different levels of motivation that influence an individual to make decisions.		X	X		Yes	(Ryan & Deci, 2012)
Multi-level perspective	Segmented approach to analysing the different levels of stakeholders in an ecosystem and how resistant they are to change.	X		X		Yes	(Geels, 2012)
Holt's branding model	• Considers societal ideals and contradictions in branding. • More abstract than practical.			X	X	No	(Holt, 2004)
Banister's framework	Practical framework for policy makers to communicate change from the top to bottom level, by building trust.		X	X	X	Yes	(Banister, 2008)

We see that Diffusion of Innovation (DoI) provides a comprehensive overall framework to base our research framework on. However, the DoI model needs to be supplemented with details, which we can gather from other models.

Sociological and psychological factors must also be considered; the formal technology acceptance model mainly focuses on the usefulness and ease-of-use of the technology, but past researches such as Ghazizadeh et al. (2012) and Chen and Chen (2011) have shown sociological factors also has significant impact on technology acceptance. This study is interested to investigate into factors of trust, privacy, beliefs of the drivers. The DoI model, together with the OBMS model, support this. The Self-determination theory also provides a good sociological tool to analyse the different motivation levels of drivers. The concept of rewards (extrinsic motivation) versus autonomy (intrinsic motivation) is interesting to be included in our investigative framework.

Though the main research question is about the individual driver's acceptance of in-vehicle monitoring, the overall study must adopt an ecosystem approach, since it is clear from current case-studies that policies and interventions from external organisations play a part affecting the driver's acceptance. The MLP model is a good fit as a tool for building an ecosystem map in our framework. Finally, Banister's framework of communicating change by building trust, provides a practical approach for organisations to introduce innovations to drivers, and is therefore selected for our research framework.

To build our research framework, we first construct an ecosystem map using MLP approach, placing the relevant stakeholders on different levels (Figure 7).

Thereafter, the selected theoretical frameworks (DoI, TAM with Trust model, and Motivation theory) are combined to form the base research framework for this study (Figure 8). Appropriate interview questions will be derived from the research framework, to be explained more in the next chapter.

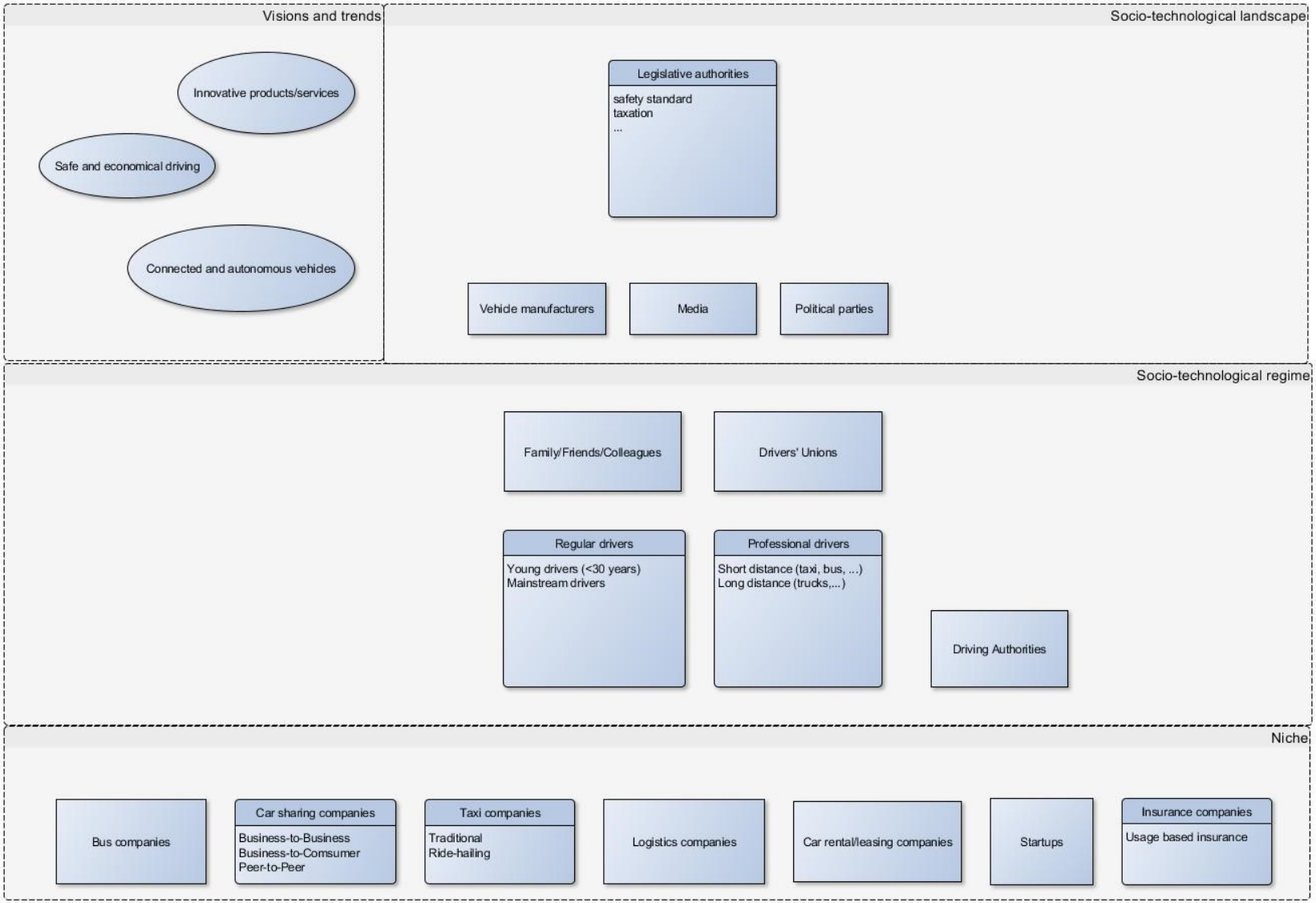

Figure 7: MLP map of stakeholders for this study

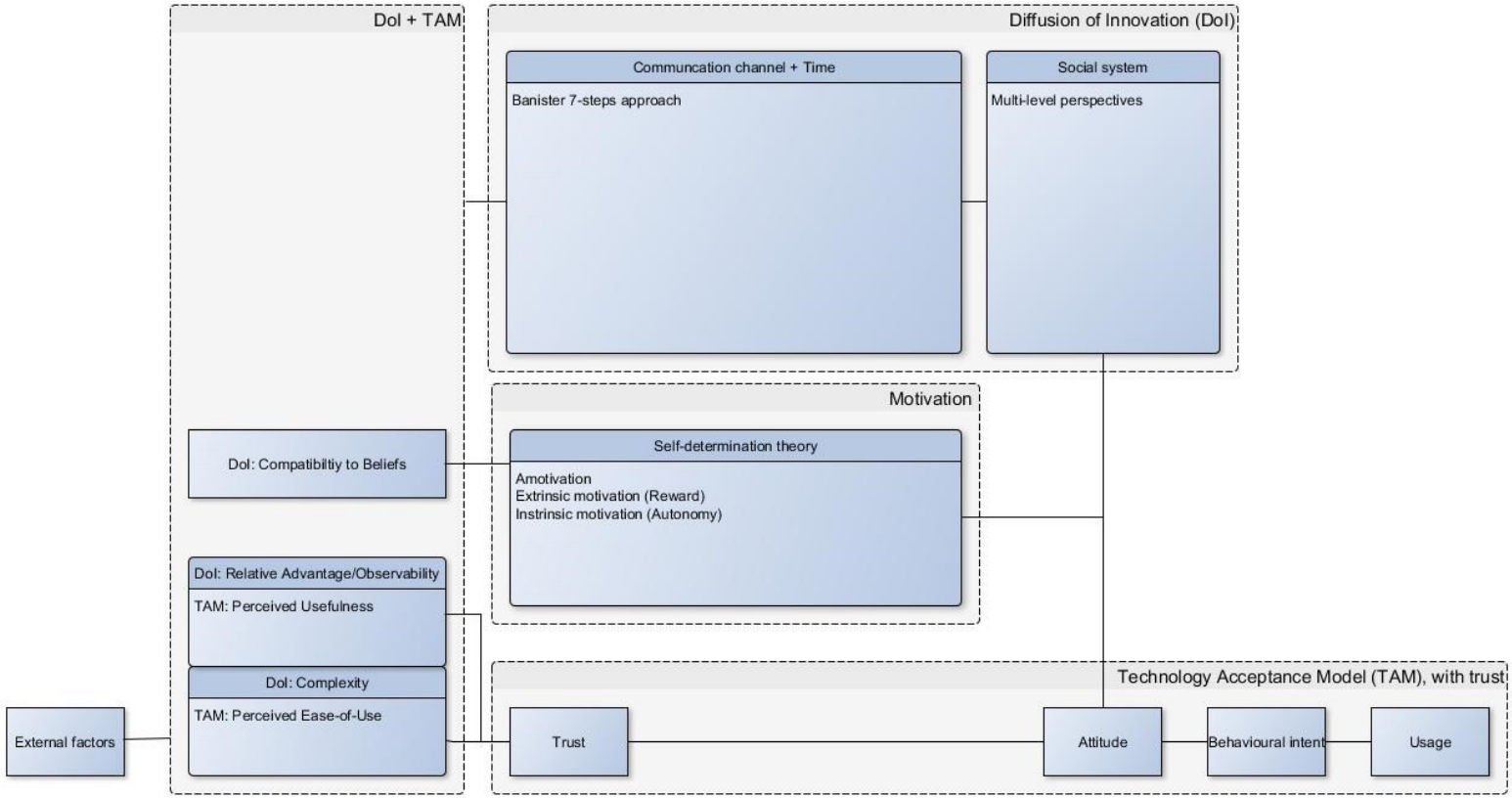

Figure 8: Overall research framework

3. Research design and methods

In this chapter, we develop the research methodology, based on the research framework and learnings from literature reviews. Appropriate questions are formulated to validate the framework, with inputs from the various stakeholders in the automotive industry.

3.1 Research approach

3.1.1 Qualitative research

Our research questions investigate factors influencing the drivers' acceptance of in-vehicle monitoring. This involves exploring the factors surrounding the phenomenon of drivers either accepting or resisting being monitored, while in their vehicles. This open-ended exploration fits the use of qualitative research methods, as that "are often used when the scientist is interested in obtaining detailed and rich knowledge of a specific phenomenon" (Creswell & Maietta , 2002). We have also determined from the previous chapter that it is important to consider the ecosystem of stakeholders.

According to Maxwell (2009), there are five intellectual goals that qualitative research is particularly useful for:

(1) **Understanding the meaning for the participants**. In this case, the participants are the drivers and relevant stakeholders in the study. Their perspectives and understanding to events related to in-vehicle monitoring, influence their behaviour.

(2) **Understanding the context in which the drivers act and the influence on the context**. For example, how does the job influence professional drivers' behaviour when it comes to being monitored?

(3) **Identifying unanticipated phenomena and influences and generating new theories on the influence**. This exploration of the unknown may be useful for us to identify factors influencing drivers' acceptance of in-vehicle monitoring, that are not immediately obvious.

(4) **Understanding the processes by which the events and actions take place**. It is important to understand not only the eventual drivers' acceptance, but also the processes that leads to the behaviour, for example, communication and branding of messages from organisations to drivers.

(5) **Developing causal explanations**. An approach of thinking of causality involving processes and mechanisms, that can be supported by quantitative studies as a further research.

A qualitative research is appropriate for this study, as it enables us to understand the drivers' understanding and beliefs of in-vehicle monitoring, focusing on their context to explore their needs and wishes. The ecosystem approach of involving other relevant stakeholders, supports the study by considering the processes and mechanisms that influence the drivers' behaviour towards in-vehicle monitoring.

3.1.2 Data collection

In qualitative research, there are three main tools for data collection: (1) Observation, (2) Documents and texts, and (3) Open-ended interviews and survey questions (Kaplan & Maxwell, 2005).

Observation typically involves the observer's active involvement in the setting studied. By observing the system users, the observer can ask questions for clarification of what is taking place and to engage in informal discussion with users, as well as to record ongoing activities (Kaplan & Maxwell, 2005). Since our study is not fixed to any in-vehicle monitoring system, and the drivers' usage of the system takes place over scattered periods of time and is dependent on whether they have such a system installed in their vehicle, it is not practical to use observation as a data-collection tool. Observation will be better suited if we want to investigate the use of one specific in-vehicle monitoring system and the driver's reaction to the usage.

Qualitative data can also be obtained from documents, texts, pictures or photographs. We make use of some of the learnings from reports of previous researches of a similar nature and adapt the knowledge to form appropriate questions for this study. (Table 2; Table 3; Table 4).

Open-ended interviews can range from an informal and conversational interview to one with a specific agenda. Open-ended interviews are used to elicit the respondent's views and experiences in his or her own terms and it is not bound to a rigid interview format or set of questions. The interviewer elaborates on what is being asked if a question is not understood, follows up on unanticipated and potentially valuable information with additional questions, and probes for

further explanation (Kaplan & Maxwell, 2005). In this study, semi-structured interviews can be used effectively to get the drivers' and organisations' input on their thoughts on in-vehicle monitoring, especially from those drivers or organisations who have already been using in-vehicle monitoring systems for some time.

3.1.3 Data analysis

There are three main groups of qualitative data analysis: (1) Coding and thematic analysis, (2) Narrative analysis and individual case studies, and (3) Memos and displays (Maxwell, 2009).

The goal of coding and thematic analysis in qualitative research is to break down the data and categorise it, so that we can compare and derive new information. In this study, coding is useful as a tool to analyse the various inputs that lead to identifying the factors influencing the drivers' acceptance of in-vehicle monitoring. The collected data should be broken down into categories, according to the overall framework derived from the previous chapter, and then analysed so that we get an understanding of the process and mechanisms that lead to the identified factors.

Narrative analysis attempts to understand the data in context so that relationships between different statements and events can be identified. Narrative analysis is useful in this study as it enables us to link information to the context of in-vehicle monitoring, for example, what is important to the driver while driving, or what the driver thinks can enable him to drive better. This supporting information can help us to establish a more holistic understanding of why the driver accepts or resists to being monitored while driving.

Displays and memos serve as a visualisation tool for analysing the collected data. These tools facilitate data reduction and the thinking of the relationships between the data. Tables and matrices are particularly useful tools for this and will be used later in the chapter to present the analysed data.

In all, the data analysis tools presented above are relevant and will be used in combination for this study.

3.2 Selected research methods

3.2.1 Semi-structured interviews

Semi-structured interviews are selected as the main method for data collection. Interview questions are formulated from the learnings of the literature reviews and interviews are carried out with drivers, companies, authorities and unions in the automotive and transportation industry.

Both private and professional drivers are interviewed, with an age and driving experience range. For the professional drivers, a mix of long-distance truck drivers and short-distance bus or taxi drivers are interviewed. It is necessary to interview both private and professional drivers, as both groups are exposed to in-vehicle monitoring in different ways and therefore may have different attitudes and acceptance towards it. The age range also gives a perspective whether the general experience of the driver plays a part in the acceptance of in-vehicle monitoring.

Representatives from local transport agencies and traffic research institutes are interviewed to get the perspectives from a high-level policy making. They also gave good insights from lessons learnt from a past in-vehicle monitoring project that was generally deemed to have failed in its launch.

Commercial organisations, such as car-sharing and automotive-finance companies, are interviewed to get insights from the business perspective on what to consider when implementing products and services with in-vehicle monitoring. Finally, representatives from the drivers' unions gave their input on their views on in-vehicle monitoring and on what drivers expect.

3.2.2 Coding and thematic networks

For data analysis, I selected the main method of coding and thematic networks.

Thematic network is a way of organising a thematic analysis of the qualitative data by categorising the themes in the interview text in three levels (Attride-Stirling, 2001): (1) Basic theme, the lowest-order theme derived directly from the text, it often needs to be read together with other basic themes, to make sense beyond its immediate meaning. (2) Organising theme, the middle-order theme that organises and present the main idea proposed by several basic themes. It is more abstract and more revealing than that presented by the text. (3) Global theme, the highest-order theme that groups several organising themes and presents the main issue within the context of the analysis (Figure 9).

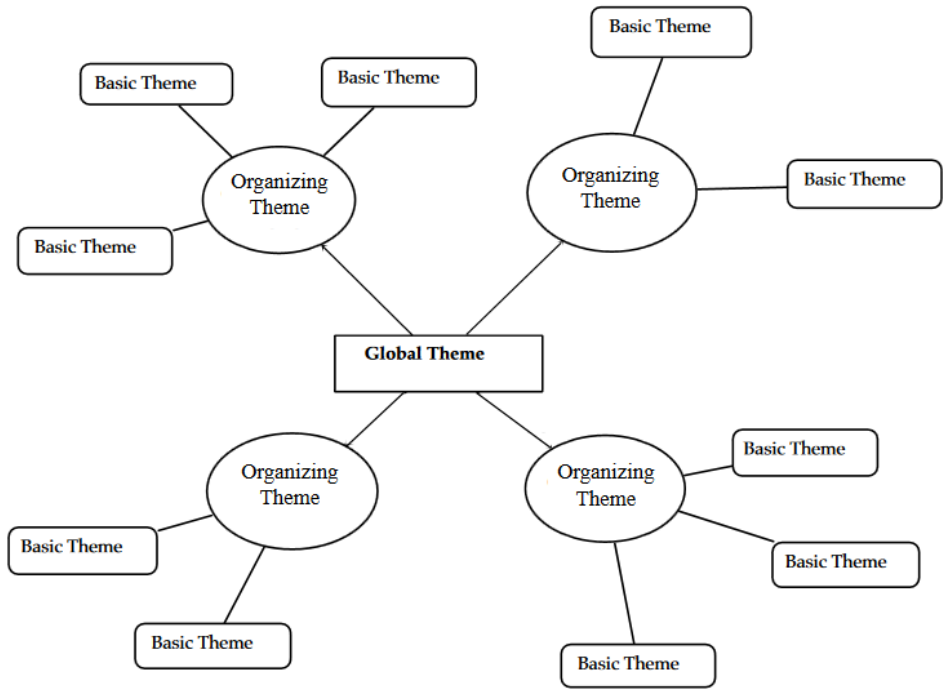

Figure 9: Structure of a thematic network (Attride-Stirling, 2001, p.388)

Since we aim to map out several factors that influence drivers' acceptance of in-vehicle monitoring, thematic network is a good tool to enable us to start analysing the basic themes, starting from the coding of the interview text, and gradually abstracting upwards to derive the global theme that represents a single factor that influence the drivers' acceptance of in-vehicle monitoring. With several identified factors (global themes), we can then proceed to discuss the results in the later chapters.

The general steps in the thematic network approach are: (1) Code the material. (2) Identify basic themes from the coded material. (3) Construct the thematic networks, by identifying the organising and global themes. (4) Explore the global themes. (5) Summarise the thematic networks. (6) Interpret the thematic networks.

3.3 Research procedures

3.3.1 Interview stakeholders

The interviews were conducted with 19 stakeholders over a period of 2 months. The stakeholders are selected to represent a mix of drivers and organisations. I interviewed both regular and professional drivers. On the organisations side, commercial companies, transportation organisations and drivers' unions are represented.

To get more diverse inputs, I selected 11 drivers of both genders with an age range from 21 to 51 years old and with driving experience of between 3 to 31 years. Out of the 11 drivers, 5 are regular drivers and 6 are professional drivers. Short descriptions of each driver follow:

1) JS, 23, is a university student and he also drives as a long-distance truck driver on weekends, delivering fuel from one station to another. He is a car enthusiast and keeps himself up-to-date with current car technology. He has a practical approach to using technology.

2) SP, 27, is an R&D scientist who uses her car to commute to work every day. The safety and comfort of driving are the most important for her, especially so that she transports her friends regularly in her car.

3) GH, 26, is a business development manager at a start-up company. His car was driven from his home country to Finland, where he now uses it semi-regularly for practical tasks, like grocery shopping or long-distance visits to parks. He is very conscious of his private information.

4) JP, 30, is an entrepreneur who is developing an eco-friendly product. He drives an old and small car, which he stated as his preference. For him, driving economically is a goal, as he is very conscious about the environment. He is also a big supporter of the sharing economy.

5) KV, 51, is a software developer who also drives part time for a taxi company, using his own car. He enjoys making the extra income but is cautious about the type of passengers who board his car. Being a software developer, he is also very curious on how car application technology work.

6) LP, 27, is an entrepreneur who drives part time as a food delivery driver on weekends. He focuses on well-being, especially on mental health, and he is very cautious on how technology affects one's well-being.

7) NS, 36, is an IT consultant who drives to work every day with his car. He has a good knowledge of data privacy and security issues, as it is related to his daily work.

8) JH, 21, is a full-time truck delivery driver. He is very pro-technology and willing to test new technology solutions.

9) JM, 22, is a full-time truck delivery driver. He is very particular about work-life balance and is concerned about his privacy when he is off-work.

10) RA, 42, is a bus driver who drives for a company in shifts. He is very proud of his profession and always tries to find and suggest better ways of driving.

11) VL is an educator who has special interest in automotive topics and drives an electric car. He collects data from his car and thinks that more can be done to derive insights from it.

I also interviewed personnel from 8 organisations that are related to transportation. These are commercial companies offering automotive related products and services, public transportation agencies and research agencies who have done transportation studies. Short descriptions of the organisation and its representative follow:

1) MI, CEO of a car-sharing company. This car-sharing company leases cars and then provide them to other businesses to share among their employees. The car-sharing is done using an application on smartphones and data is read from the car occasionally, for example to know where the car location is. Customer experience and satisfaction is important to the company and they aim to make car-sharing as easy as possible.

2) TP, risk manager of an auto-finance company. This auto-finance company provides financial loans to individuals to purchase cars, using both open-ended and close-ended plans. The company wants to reduce its risk of getting back cars in bad condition, in event that the customers do not pay back their loans.

3) RK, advisor to a transportation agency. This agency is concerned with providing good infrastructure to support road usage. The use of monitoring is mostly in getting information that supports planning of vehicle flow. RK also has experience with other projects concerning in-vehicle monitoring.

4) IH, project engineer in a research agency. This agency provides research work mostly in technological solutions, including transportation. IH was involved in doing research concerning data privacy of an in-vehicle monitoring project.

5) SM, expert advisor in a transportation agency. This agency implements the guidelines concerning the use of vehicles, for both private and commercial drivers. SM was involved in an in-vehicle monitoring project and he is particularly concerned about making a product or service that users desire.

6) MR, implementation manager in a drivers' union. This union serves a professional driver's industry and provides tools and services for businesses various sizes, especially helping the small owners. MR's view on technological solutions is that there is often a cost challenge for the small sized companies to adopt the technology. MR is a big supporter of drivers' training.

7) SH, CEO of a mobility company. This company has launched an innovative application that integrates different forms of transportation for consumers. SH is a big supporter of open standards among the industry players.

8) TC, project engineer of a research agency. TC has been involved in research of business models in an in-vehicle monitoring project.

3.3.2 Design of interview

Since there are 4 distinct groups of interviewees: (1) Regular drivers (2) Professional drivers (3) Automotive-related companies (4) Transportation and research agencies, I first had to formulate the lists of questions to be used in the different interviews (Appendix 1; Appendix 2; Appendix 3). Each interview lasted approximately between 45 minutes to 1 hour and the conversation was recorded for transcription.

For all the interviews, there are two essential questions:

(1) In your opinion, what are the factors that encourage drivers to use more in-vehicle monitoring?

(2) In your opinion, what are the factors that stop drivers to use in-vehicle monitoring?

3.3.3 Execution

As the interviews are semi-structured, I adopted a free-flow approach, first by forming general questions about driving and monitoring, and then asking questions about in-vehicle monitoring that relates to each topic area described by the research framework (Figure 8). I first chatted with the drivers about their driving experiences, what their needs are and what is important to them when they drive. From there, I attempt to understand their motivations and try to relate it to in-vehicle monitoring. Subsequently, I introduced the concept on in-vehicle monitoring and asked them about what they think it is about, and what have they read/heard about it. I touched on the various topic areas, like trust, control, services, rewards, social influences, to get their input.

3.3.4 Drivers' perspectives

For both regular and professional drivers, as part of narrative analysis, I wanted to first understand their general mind-set when it comes to driving and being monitored. I started by asking questions like: "What features in the car do you find most useful?", "What is important to you during the drive?" and "What do you think can enable you to drive better?", so that I get better insights on what is generally important and useful to the drivers, that might be fulfilled by in-vehicle monitoring.

I also encouraged the drivers to think of and describe a past event that they were being monitored for any activity. The idea is to get their general feeling towards being monitored in any situation.

Next, I asked the drivers on what they think "in-vehicle monitoring" is about, and then recall the previous time that they were monitored while driving. The approach is to get their initial perception of what "in-vehicle monitoring" is, and then hear their concerns about it when I described the concept more.

Subsequently, I asked questions that are related to the different areas in the research framework. I prepared a list of topical questions to move the conversation along when needed.

3.3.5 Organisations' perspectives

For companies and unions, I am interested to understand their perspectives on how in-vehicle monitoring is used in their current products and services. I want to understand what they think is valuable to their customers, what they think their customers' attitudes towards being monitored are, and how do they take this into consideration in their products and services. I used a similar list of topical questions according to the research framework, to hear the organisations' opinions.

3.3.6 Transport and research agencies perspectives

For transport and research agencies, since they do not have commercial interests in in-vehicle monitoring, my approach was to interview them from a policy perspective, on how in-vehicle monitoring helps in achieving their organisation's goals, what is their vision of such a system and who are the important stakeholders. In addition, since the participants were involved in a past in-

vehicle monitoring project that was generally deemed to have failed, I am also interested to hear their perspectives on what went wrong and what could have been done better.

3.3.7 Analysis

The semi-structured interviews were transcribed in verbatim using ATLAS.ti 7 software and then analysed using thematic networks. The analysis and results are presented in the next chapter.

4. Results

The results of the thematic network analysis are presented below to answer the two research questions.

4.1 Factors influencing drivers' acceptance of in-vehicle monitoring

Table 8 shows the drivers' common responses to questions about their thoughts on in-vehicle monitoring and the percentage of them who responded this way:

Table 8: Drivers' responses to in-vehicle monitoring

Question	Regular drivers (5 drivers)	Professional drivers (6 drivers)
How do you think in-vehicle monitoring helps you?	Feedback for economical drive (80%)	Validation of work (50%)
How do you think in-vehicle monitoring hinders you?	Over-warning (40%)	Over-tracking (50%)
What are your concerns about in-vehicle monitoring?	Privacy (60%)	No big concern, part of work (50%)
What may encourage you to use more in-vehicle monitoring?	Knowing clear benefits (40%)	Having more responsibilities (33%)
What may stop you to use in-vehicle monitoring?	Misuse of data (80%)	Misuse of data (67%)

Regular drivers think an in-vehicle monitoring system can help them by giving feedback on how they drive, so that they can save costs and utilise their cars better. However, they do not like being overly-warned by monitoring systems, especially if the driving environment is not complicated, for example on a highway. Their main concern on monitoring is privacy and knowing the clear benefits of using such a system will convince them to try it.

For professional drivers, they feel that in-vehicle monitoring helps them by validating their driving performance, and some companies do reward good drivers. However, they are annoyed if they feel that they are overly-tracked, especially if they are constantly asked where they are and reminded of their tasks. In general, there is no big concern over being monitored as they feel it is part of their work. In fact, they feel that the more responsibilities they have, the more useful the monitoring in helping them with their job.

Both types of drivers mentioned that they may stop using in-vehicle monitoring if there is a misuse of the collected data.

To answer research question 1 in detail, I used the thematic networks approach to code the transcriptions of all 19 interviews, analysed the codes by abstraction, and then identified the basic themes, organising themes and global themes. The full coding and thematic network analysis table can be found in Appendix 5.

From the global themes, 9 factors are identified as influences on drivers' acceptance of in-vehicle monitoring. For easy reading, the factors are arranged in order of decreasing code occurrence frequency (Table 9).

Table 9: Factors influencing drivers' acceptance of in-vehicle monitoring

Factors	**Description**	**Code Frequency**
Comparing benefits and costs	The perception of receiving benefits compared to the perceived costs to the driver.	33.1%
Privacy	The processing and confidential treatment of the monitored information.	20.1%
Autonomy of driver	The feeling of choice from the driver in the monitoring system, the collected data and the use of the data.	11.8%
Driver's ideals and morals	The support of the driver's ideals and morals.	9.4%
Ownership of vehicle	The perception of who owns the vehicle.	6.3%
Trust	The level of trust from the driver in the collected data and organisation that collects the data.	6.1%
Design of system	The design aesthetics and usability of the monitoring system.	6.1%
Awareness of the technology	The overall awareness level of the driver of in-vehicle monitoring, how it works and its benefits.	5.8%
Media and marketing	The general marketing and quality of the messages put across by the mass media.	1.4%

4.1.1 Comparing benefits and costs

"What is in it for them? What is the benefit for them? It will be that it is nuisance for them anyhow, so they have to get something in return. And if that is good enough, why not?" - RK

"If there is some data that you can get them before they (vehicle) break down, it is always better to fix them before they break down" - JH

"A reward for somebody to track me and I get rewarded for that? If you market that monitoring system with just a discount, I would say it is kind of iffy." - JM

The perception of receiving a benefit from the in-vehicle monitoring system, compared to the cost of sacrifice of the driver, is an important factor. It is unanimous that drivers should get some benefit

back from a system that monitors them, and the benefits needs to be proportional to the perceived costs of the driver. However, the costs to the drivers are variable and it can range from a tangible cost of repairing a vehicle that has broken down, to an intangible cost of sacrificing one's privacy in exchange for services from the monitoring system. Therefore, it may not be enough to apply a one-size-fits-all benefit system, as the benefits may need to be tailored to the different types of drivers and their needs. To analyse deeper, I further break-down benefits into sub-factors in Table 10:

Table 10: Different types of benefits to drivers

Sub-factor	**Description**
Safety	Benefits that protect the safety of the driver, as well as the occupants or people in the surrounding environment.
"Feeling the value"	Benefits that are perceived to support the driver's needs and wishes.
Economics	Benefits that give a tangible advantage to the driver.
Efficiency	Benefits that increase the performance of the driver in various situations.
Knowledge	Benefits that enhances the information that the driver has.
Business and services	Benefits that are provided by commercial organisations as services.
Reward	Benefits that gives something to the driver if he accepts to be monitored.
Proof of performance	Benefits that provide evidence of the drive and skills of the driver.

For safety, drivers appreciate in-vehicle monitoring features that prevents accident during their drive. In the case that an accident does happen, an automatic broadcast of their location to the emergency services is useful. They also feel that in-vehicle monitoring can help to regulate bad driving behaviour, making roads generally safer.

It is also important for drivers to feel the value that they get from the in-vehicle monitoring system. This is best achieved when the value matches the driver's need. It was noted that the real value

from the system does not have to be substantial; the driver just needs to perceive that he is getting some value that fulfils his needs.

Economic benefits give drivers a tangible value, for example protecting his interests while he is driving, helping him to save costs by protecting the value of his vehicular assets, or saving money in various ways, such as giving feedback for economical driving to achieve fuel efficiency.

In-vehicle monitoring systems that improves the efficiency of the driver are appreciated, especially by the professional drivers. For example, improving the fuel efficiency, getting tasks done in a shorter time or making it generally more convenient for the driver to finish his drive.

Drivers also appreciate knowledge from in-vehicle monitoring systems. Knowledge that empowers them to make better decisions, for example deciding if the mechanic's claim for car maintenance is valid and worthwhile. Knowledge can also help the driver to improve the way he drives, which is important for professional drivers who are measured for this. In-vehicle monitoring systems that gives drivers a flexibility to explore his surroundings and discover new places and services, are also appreciated.

Benefits can be provided by commercial organisations, in terms of products and services. With in-vehicle monitoring, it is expected that the service quality will be improved, and the drivers see a clear and attractive business case for them to agree to be monitored. The monitoring may also present new business opportunities for drivers, for example, in the form of peer-to-peer car sharing, where the car is monitored for its use by different drivers.

Reward is another benefit that may be attractive to drivers, even though it must be perceived as sincere and proportional to the sacrifice. Rewards can come from commercial service providers or the employers of the drivers.

Finally, in-vehicle monitoring system can help driver to validate that tasks have been completed and provide evidence if an incident occurs while driving. For professional drivers, it is also a form of certification of good driving, which may sometimes be required to be produced in their job.

4.1.2 Privacy

"The difference is that information can be transmitted out only if it has been analysed in the car and only the result will be transmitted outside." – NS

"If it just starts to invade my personal life too much, if I feel that I am constantly tracked not in a good way, so that it starts to stress me out, I will stop using it. As long as it is not in a stalking kind of way" – JM

"If I will be monitored, I will be monitoring myself for myself. There must be something extraordinary for me to share my private data with someone." – GH

Privacy is another important factor in the drivers' acceptance of in-vehicle monitoring. Drivers are generally more acceptive if their identity is anonymised and the data transmitted out of the vehicle is abstracted to contain only the results, instead of the raw data. However, organisations also feedback that the more anonymised and abstracted the data is, the more difficult it is to provide a personalised service to the driver that is attractive to him.

4.1.3 Autonomy of driver

"Yes, it is okay if it is to my agreement that they can obtain information and they are telling clearly what they are doing with the information and what are the benefits." - NS

"I don't think you really have an influence, because if the (job) contract says that the car has to be monitored, it is just a matter if you want to drive the car." - JS

"I think it is okay when it is recording when I want it to. On-demand is okay, but if it is automatically, then it is scary, yeah." - SP

The autonomy of the driver describes whether the driver has the feeling of choice of being monitored. For example, can he decide when to activate the monitoring and what is the type of data being collected by the system? Is he also able to decide who receives the data and how the data will be used? With the professional drivers, it is clear that they are aware that they do not have a choice when it comes to their jobs; their vehicles must be monitored, and therefore they are generally more acceptive towards in-vehicle monitoring systems. With regular drivers, they expect to be in control at different stages of the data-collection.

4.1.4 Driver's ideals and moral

"Monitoring is ultimately needed. Recklessness leads to life danger. So, if you ask me, monitoring things, I expect even more monitoring of the driver, as he is the pilot of the bus." - RA

"I think it is totally fair that if there is monitoring, it means the service can be better and people treat their vehicle with respect, the way they should do anyway." - JP

"We collect information and then we try to manipulate people, that is maybe the thing I am worried about." - LP

It was evident that after the interviews, different drivers see in-vehicle monitoring systems in strengthening or challenging their own morals and ideals. Drivers who feel that in-vehicle monitoring systems support their ideals, in terms of improving the technological level of cars, or protecting the public good and the environment, are more acceptive of the technology. Especially, professional drivers have no issues being monitored while driving for their work, as they are aware

of their job responsibilities. Those who are against in-vehicle monitoring, are mostly concerned about being manipulated by organisations who use the data inappropriately or for overtly explicit commercial marketing.

4.1.5 Ownership of vehicle

"I think it won't be a problem, when it (monitoring) is part of someone else's service, there is certain terms, like if I want to use this car, I have to accept it. The difference is there: who owns it?" - MI

"With the company car, I think everything (monitoring) is okay, because it is not my own car." – LP

"If somebody else was tracking my personal car, then I will not like it so much. Because it will affect my personal life." - JM

The ownership of the car is a clear-cut factor; drivers who own their vehicles are more unwilling to be monitored than drivers who drive vehicles that are owned by companies. The clearest distinction comes from the professional drivers, who are perfectly alright to be monitored while on their job but are generally not willing to be monitored when they drive their own cars in their private time. Also, companies that own fleets of car and provides a service to their customers, generally do not face resistance by their customers about the monitoring, as it is accepted as part of the service and their customers' need to use the car is bigger than giving up their private information.

4.1.6 Trust

"I wouldn't mind if there is somebody else who is trustworthy, taking the information. I don't mind at all, but I need to know who is it." – NS

"They use tracking to measure the efficiency of the car, I don't mind it because if I would like, I can ask them how I am doing." – JM

"I would say the best 3 people to access my personal information are: me, myself and I." – JM

Trust is an important factor that is often mentioned with autonomy and privacy. This mainly affects the data and the organisation that is collecting the data. For example, how accurate is the data, and is there a way to check the accuracy? How secure is the data transmission and how is the reputation of the organisation which collects the data? How does the organisation use the data and are there policies in place to protect against the abuse of data? Some drivers have doubts in trusting large organisations, even if it is the government. Table 11 shows stakeholders who are generally trusted by the interviewed drivers:

Table 11: Trusted stakeholders by interviewed drivers

Law enforcement agencies
Direct service providers, e.g. doctors
Companies with good reputation
EU countries
Government
Independent party checking the system
Vehicle manufacturer
Family
The driver

Law enforcement agencies and direct service providers are generally trusted, as they provide critical safety and beneficial services to the drivers. The trust in EU countries came from the strict privacy laws that are in place and will be enhanced in 2018. The trust in government is slightly more controversial; some opined that while governments can generally be trusted, they prefer that minimal data is captured and stored, in view that politics can change over the years and the trust in successive governments may change over time.

4.1.7 Design of system

"The main problem was the user interface, I think if we have also a good service, then it is going to be used." – RK

"Our (monitoring) equipment wasn't like Apple equipment, it didn't look so nice and wasn't so beautiful as the packages in Apple." - SM

The design aesthetics of the in-vehicle monitoring system also plays a part in the driver's acceptance. A previous similar project had good experimental results, but the drivers were not willing to purchase the equipment. The general opinion is that the equipment simply did not looked attractive to be purchased. Another project had the number of subscribers dropped after the initial usage, and the feedback was that the usability was low; the system must be manually started each time and users found it difficult even to register for the service. The general opinion is that any in-vehicle monitoring system should have an interface that is pleasing to look at, easy-to-use and largely invisible to the driver, working in the background.

4.1.8 Awareness of the technology

"Drivers are normal people who accept whatever when they are trained, when they are told why, not simply told that you must, but this is your job and this is the reason why you do this." - MR

"It is the lack of knowledge which becomes a fear or a barrier. Like, I don't want to be monitored because I don't want it to affect me." - MR

"The ironic thing is that we are constantly being watched anyway, and everyone has a smartphone that monitors, without us knowing it. We tick the box, we don't read the fine print, we just want to get great service for free." – TC

The overall awareness level of the driver towards in-vehicle monitoring is a factor. When the drivers know how it works and how it benefits them, then it helps in the acceptance. Younger drivers tend to be more savvy and knowledgeable about such technology compared to the older ones. For professional drivers, training is also a factor; drivers who are trained, are more acceptive

of the technology. Ignorance of the technology can lead to fear of its introduction, especially if the adjustment period is short. However, ignorance can sometimes also be helpful, some interviewees opined that the less the drivers know, the less doubts and fear will be raised.

4.1.9 Media and marketing

"All these kinds of changes are very hard in our society, there is always resistance against new ideas, new systems." - IH

"They did not have a good marketing plans for how to introduce the whole thing." - IH

The marketing of the in-vehicle monitoring system by organisations, plays a part in its acceptance. Targeted marketing is useful when it considers the changing needs of a user segment. The marketing can also use branding concepts that target influencers in social media. The general opinion is that the time of engagement of the media plays a part in the success of the product launch; the media should be engaged early in the process of developing the system, and the media message must be clearly defined and focused on the benefits on the service, instead of the monitoring. The transportation agencies concurred that the previous implementation of a monitoring system project failed because they had not worked with the media early enough to plan a good marketing campaign, and they immediately faced resistance from the media when the product was introduced.

4.2 Considerations for organisations implementing in-vehicle monitoring

To answer research question 2, I analyse the findings from the drivers from the previous research question and combine them with findings from the 8 organisations that I spoke to. The main inputs

and learnings from the interviews with organisations are shown in Table 13. From the inputs of drivers and organisations, 4 main themes are inferred that need to be considered by companies and organisations which want to implement in-vehicle monitoring in their products and services (Table 12):

Table 12: Considerations for organisations that want to implement in-vehicle monitoring products/services

Themes	Description	Considerations
Privacy, trust and security.	The secure collection, processing and usage of data.	• Adherence to standards, policies and laws. • Design of the chain of data collection: o Level of anonymity of user. o Level of details of data. o Location and storage of data processing. o Level of user control and permission. o Level of human access to system. o Selection of user of data. o Feedback channels for clarification of data.
Design and ease-of-use.	The design and usability of the in-vehicle monitoring system.	• Level of engagement to drivers: o Appeal of the design. • Driver-centric design: o Level of obtrusiveness and user interaction. o Amount of information to drivers. o Type of reports to drivers.
Business model	The provision of the service to drivers.	• Appeal of business case for drivers: o Type of benefits for drivers. • Openness of system to stakeholders: o Level of support for ecosystem.
Marketing	The communication and branding for the in-vehicle monitoring service.	• Content of the marketing: o How the target message relates to the beliefs of drivers. o The focus on the benefits. • Communication channels: o Timeline.

4.2.1 Privacy, trust and security

"If you have too tight privacy law and too tight attitudes against privacy issues, then you cannot personalise any service and provide such a good service level for individuals." - IH

"If there are technologies like blockchain, or something integrated to it, so you can also monitor where your data has gone." – JP

"Yeah, there is the issue of trust, when it is a huge organisation, when they are collecting the data, especially if they are the government." – MI

Privacy and trust are 2 important factors that influence drivers' acceptance of in-vehicle-monitoring, and consequently, companies should consider these when developing their product and services. Companies should consider how in-vehicle monitoring products adhere to existing laws and policies that protect the consumers. Also, the security of the whole chain of data collection, from the data source to the transmission to the recipient, should be considered in how it supports the privacy and trust of the drivers.

The identity of the driver can range from full anonymity to full identification. This may come at the expense of designing a personalised service. Similarly, companies should also decide how much details in the data to process; should all the data be sent for processing, or can it be abstracted to send only the important details? The location of the data-processing is another consideration; can it be done locally in the vehicle or must it be transmitted to an online server? The organisation should also consider the level of human access to the system; enabling drivers to control their data movement enhances transparency, however the security risk also increases when more people have access to the system. Some organisations opined that having multiple layers of access increases the security of the system. The selection of the final user of the data is important; a trusted party, for example a company with good reputation, will be accepted more by users. Finally, feedback channels should be made available for the drivers to clarify the data, especially if there are

ambiguities. Recommendations for the design of the data collection will be discussed in the next chapter.

4.2.2 Design and ease-of-use

"I've heard of gamification, applications which companies make a common game, of which drivers are able to drive in a certain manner. The user is really involved and maybe interested in what happens to the data." - TC

"We are moving from driver to the passenger to the consumer, and there will be more automation in the car. How the information is given to the driver, it is really related to the ergonomics, so that the driver is not over-loaded with this information." - SM

The level of engagement of the in-vehicle monitoring product/service should be considered by organisations. On one hand, a feature like gamification engages the driver and make them interested in the system. On the other hand, there should be care not to overload the driver with too much information, since his main task is still to drive. The driver-centricity of the design of the system should be thought through by the company. The design should primarily consider the driver at every stage, on what the driver's role is, and what type of information and interaction is meaningful to him.

4.2.3 Business model

"I think the ideal case for the data that is taken from me, is that I can control it and as a consumer, I can choose the best service. If I am not happy with the way they are using my data, I can switch to another service provider." - TC

"The right business model is that the government is responsible only for coordinating things, the market will provide all those sub-systems and so there will be competition, prices will decrease, and quality will increase." - IH

"One of the major issue in all of these is standardisation. Because many of these features should not be just car-brand specific solutions, because they are harder to get through." – SH

Organisations should consider the design of the business model between the company, drivers and other stakeholders. The type of benefits and control provided to the drivers, will influence his appeal to the product. While organisations develop their own intellectual property, they should consider how open their system should be to support the transfer of information across service providers, so that the drivers get to choose the service that fits them best. It is generally agreed that standardisation and an open system will increase the competition and provide the best service levels to the drivers, and this can be best facilitated by governmental agencies.

4.2.4 Marketing

"Of course, there are some issues related to that tracking, but there are some positive aspects too, and those positive aspects were not introduced so much." – IH

"There was too much pressure from the government side to put this kind of scheme into practice in a short period of time and the schedule was too tight." – IH

Finally, organisations should consider their marketing of in-vehicle monitoring products and services. The content of the marketing message can be tailored to target the beliefs of the drivers and the benefits, for example dispelling the beliefs of a big brother surveillance state and focusing on the benefits that appeal to the drivers' needs instead. The type of communication channel should be selected with the medium that the drivers use most often, for example an appropriate social media channel. The timeline of the marketing should also be planned to allow sufficient time for the drivers to get used to a new product. Design and marketing recommendations for organisations will be discussed and presented in the next chapter.

Table 13: Summary of inputs from companies and organisations

Organisation	Topics							
	Use of monitoring	**Driver's concern**	**What will encourage drivers to use more monitoring**	**What will stop drivers from using monitoring**	**Business model**	**Benefits to drivers**	**Marketing**	**Social influence**
Commercial companies	Part of their product offering.	Misuse of data, otherwise they do not care.	Direct benefits.	Invasion of privacy.	Support the ecosystem, work with partners on providing service.	Transfer cost savings to customers, using service provider. No penalties.	Focus on feature set, changing needs and emotional core of customer and use word-of-mouth.	Use it for education to encourage acceptance.
Transportation agencies	Infrastructure planning and safety.	Security, Otherwise they do not think much about it.	Visible benefits / Invisible design.	Privacy, bad use-end-use.	Identify clear need of drivers. Consider driver's transitioning role from driver-passenger-consumer.	Benefit of information and discounts.	Involve the media but not forced through.	-
Research agencies	-	Big brother, government surveillence.	Visible benefits and design.	Cost and lack of ecosystem.	Better service by government led standardisation, open system for increased competition.	Economic benefit from private sector. No penalties, especially from law enforcement.	Focus on benefits over time. Differentiate public versus private needs.	Tap to existing social groups to spread message.
Drivers' union	Fleet management for vehicle.	Big brother surveillence.	Training	Cost of monitoring.	Scaling up business for compliance reasons.	Providing good support.	Face to face, simple communication.	Not so effective.

5. Discussion and conclusions

The analysis and results from the previous chapter have both theoretical and practical implications to the design and implementation of an in-vehicle monitoring system. The main learnings are described here, and recommendations are made for organisations which implement an in-vehicle monitoring system in their product or service.

5.1 Theoretical implications

Here, we use the identified factors influencing drivers' acceptance of in-vehicle monitoring and relate it to the theories used in the research framework.

5.1.1 Review of DoI and TAM models

Table 14: Comparing results to factors in DoI and TAM models

Factors influencing drivers' acceptance of in-vehicle monitoring	Code Frequency	Equivalent factor in DoI	Equivalent factor in TAM
Comparing benefits and costs	33.1%	Observability	Perceived usefulness
Privacy	20.1%	Compatibility to beliefs	*(not applicable)*
Autonomy of driver	11.8%		
Driver's ideals and morals	9.4%		
Ownership of vehicle	6.3%		
Trust	6.1%	*(not applicable)*	TAM with Trust
Design of system	6.1%	Complexity	Perceived ease-of-use
Awareness of the technology	5.8%	Communication channel / Time	*(not applicable)*
Media and marketing	1.4%		

From the identified factors that influence drivers' acceptance of in-vehicle monitoring, the top 2 factors, that form more than half of the input, are "Comparing benefits and costs" and "Privacy"

(Table 14). If we relate our findings to the rate of diffusion of innovation in DoI (Table 2), we see that "Observability" and "Compatibility to beliefs" play the major parts in the drivers' acceptance. Note that the factors "Autonomy of driver", "Driver's ideals and morals" and "Ownership of vehicle", are also part of "Compatibility to beliefs", as they apply to the personal values and beliefs of the drivers. Thus, drivers must be able to observe a high degree of the benefits of using in-vehicle monitoring, and at the same time, the usage must be compatible to their values of privacy, autonomy, moral and responsibility.

For the other factors in the rate of diffusion of innovation in DoI, since in-vehicle monitoring is a relatively new innovation, the "Relative advantage" is not so apparent, as drivers do not have an existing reference to compare to. The "Complexity" factor also plays to a lesser degree, as the design of the in-vehicle monitoring system seems to concern the drivers less than other factors.

Communication channel and time, in DoI, also seem less applicable, as "Awareness of the technology" and "Media and marketing" are the two least-mentioned factors. However, we should note that these factors were mostly mentioned by the organisations, as a reflection of how things can be done better. Since the drivers are initially unaware of in-vehicle monitoring and are exposed to limited marketing on it, it is reasonable to expect that they do not mention these factors much.

In TAM, "perceived usefulness" clearly outweighs "perceived ease-of-use" when it comes to drivers' acceptance of in-vehicle monitoring. This is quite consistent with other similar studies' finding that perceived ease-of-use is typically insignificant (Ghazizadeh, et al., 2012). However, we should note that majority of the drivers who were interviewed are in their mid to late-twenties,

and thus it is reasonable to expect them to be fairly savvy to handle the technology. It is also interesting to observe that "Trust" plays to a much lesser effect than "Privacy"; the "TAM with Trust" model is less impactful here. Perhaps "Trust" as a factor is more implicit, and drivers feel it less than a more explicit concern about privacy.

Overall, the DoI and TAM models fit nicely with the research framework and results, but more can be done to examine the communication channel of DoI, and trust in TAM.

5.1.2 Self-determination theory and the motivation of drivers

The Self-determination theory fits well when we consider the benefits that motivate drivers to accept in-vehicle monitoring. Using the sub-factors of "Comparing benefits and costs" (Table 10), we can derive and categorise the different motivations of drivers in Table 15. In theory, the desired type of motivation is internal motivation, where the person is self-motivated by his own goals and ideals.

Table 15: Motivations of drivers

Amotivation	**External motivation**				**Internal motivation**
	External regulation	**Introjection**	**Identification**	**Integration**	
Good service quality.	Tangible benefits, rewards.	Recognition as good driver.	Self-endorsement of job and technology.	Clear goals and knowledge.	Emotional appeal of freedom and being in-control (autonomy).

From the interviews, it was seen that drivers are generally amotivated and neutral towards in-vehicle monitoring, if they receive good service from the service providers. Especially in car-sharing, the value from receiving the service outweighs the perceived costs of being monitored. Therefore, it is important for organisations to design an appealing product or service for drivers. This belief is firmly supported by the car-sharing company that I interviewed. They believe that their service is so easy to use and provides a great value to their customers, that they do not mind being monitored at all, because they understand that it is part of getting the great service.

External motivation can be further sub-categorised into increasing level of internalisation of the motivation. Starting from external regulation, drivers are motivated by tangible benefits and rewards, and this can come in various forms, for example cash incentives, "sexy, Telsa-like" product designs, rewards in terms of discounts or services, time-savings, preserving the value of the vehicle, or maximising the utility of the vehicle. Organisations should consider implementing tangible benefits to attract drivers to use in-vehicle monitoring product and service.

For some drivers, just being recognised as a good driver, is motivation enough to use an in-vehicle monitoring system. When the system presents an official certification of the performance and skills of the driver, this can motivate him to use it. This can possibly be achieved for example, through a design of a game, to encourage drivers to drive better. The bus driver whom I interviewed, treats his in-vehicle monitoring system passionately as a game, and he looks forward to achieving a better score every day from his drive. This is supported by his company that recognises and rewards good "game" performance.

When the external motivation gets increasingly internalised, the driver's self-endorsement of his job and the technology that he uses, is also a source of motivation. For a professional driver, when he is proud of his job and supports the growth of the company, he is open to be monitored. Companies can encourage this by making sure that their drivers are trained sincerely, so that they feel a sense of responsibility for their job. In addition, providing tools and technologies that are perceived as "cool" to the drivers, also motivate them. The drivers' union is consistently encouraging this by organising training sessions for drivers to familiarise them with the tools.

The most powerful form of external motivation comes when the drivers have integrated clear goals and knowledge into their behaviour. For example, when drivers know how the vehicle and monitoring work, he becomes more aware of his driving surroundings, supported by his ethics and concern to do good for the public and the environment. He is aware that his driving skills will improve and roads will become safer subsequently.

The desired state of motivation is internal motivation and it is most effective when it appeals to the emotions of the drivers. We observe that "Autonomy" is the third most mentioned factor that influences drivers' acceptance of in-vehicle monitoring (Table 9). For example, many of the interviewed drivers love the feeling of freedom while driving and being in-control of their vehicle. This appeal to their emotions also comes when they feel bored and want to break out of their routine, or when they feel that they can help others. An in-vehicle monitoring system that can adapt and appeal emotionally to the drivers' internal motivation is more likely to be accepted. However, it is also the most difficult to design, since it involves deep understanding of the needs and wishes of different segments of drivers, and their needs change over time and environment.

In summary, an in-vehicle monitoring system should be designed to target the different motivation levels of the drivers. And it is easier to start from external motivation, working towards the goal of internal motivation.

5.2 Practical implications

Here, we discuss practical design considerations for the in-vehicle monitoring system and provide recommendations that organisations can use in their products and services.

5.2.1 Supporting drivers' perspectives towards driving

Table 16 shows the themes of the most common responses from drivers, to the questions about their perspectives towards driving in general. There does not seem to be a clear difference due to their age, gender or driving experience of the drivers.

Table 16: Drivers' perspectives towards driving in general

Question	Regular drivers	Professional drivers
What is important to you during driving?	Safety	Tasks completion
What can make you drive better?	Feedback for economical drive	Guidance
What can let you enjoy driving more?	Less stress	Distraction from work

We see that professional drivers have very different goals and needs when they are driving for their job, compared to regular drivers. For professional drivers, their main concern during the drive is to finish their tasks. Therefore, they appreciated technology that helps them to do so. For

example, technology that provides guidance, giving advance information of road segments with heavy traffic, or helping them to do their tasks efficiently. The truck drivers whom I spoke with, enjoy taking moments of distraction in their work; they appreciate it when technology helps them to take some rest, for example a system showing the location of their colleagues on the road, enabling them to meet for a coffee break.

For regular drivers, their main concern during the drive is the safety of themselves and their passengers. They appreciate technology that reduces the amount of stress during the driving, for example adaptive cruise control, or music from a blue-tooth connected smartphone. In fact, adaptive cruise control is mentioned most frequently by the drivers, as the favourite feature of their car. Fuel economy is a factor that is important to the regular drivers and they appreciate feedback of how efficiently they are driving, so that they can save costs and utilise the car better.

An in-vehicle monitoring system should be designed so that it targets what is generally considered important to the different types of drivers, keeping in mind the factors that are identified in the previous chapter.

5.2.2 Data privacy and security of in-vehicle monitoring system

Privacy, trust and autonomy are 3 important influencing factors that have been identified from the study. The challenge lies in how to use these factors in an in-vehicle monitoring system. One approach is applying these 3 factors to the collection, processing and usage of data by the monitoring system.

Figure 10 shows the overall technical setup of an in-vehicle monitoring system, from the data source, transmission to server and the recipient of the collected data.

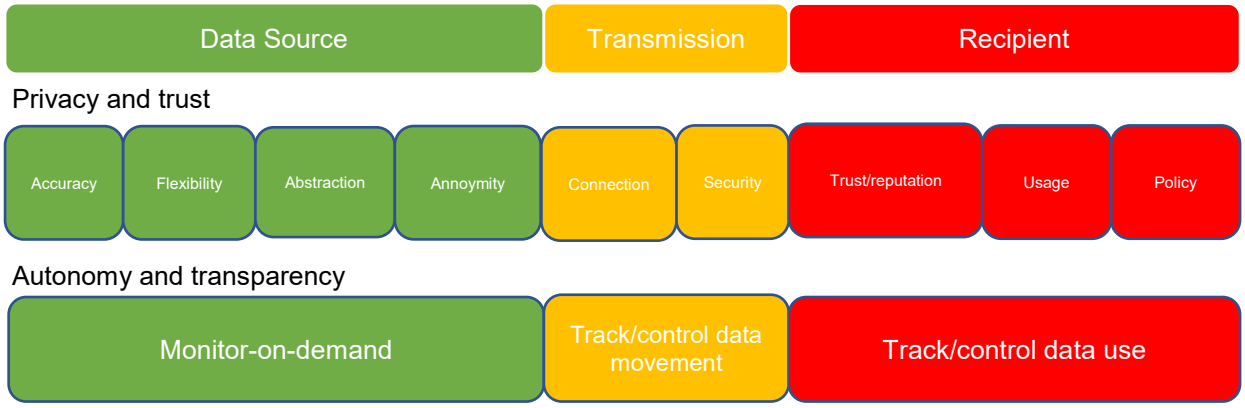

Figure 10: Recommendations for technical setup of in-vehicle monitoring system

When we consider the data source of the system, this is typically the device that is installed into the vehicle, reads information from the vehicle CAN bus, processes it and then transmits the data or result to the server. At the data source, the designer must check the accuracy of the data; how close to the raw data does the device collect? If there is a deviation, it may cause a wrong result to be calculated. Therefore, it is important to check the accuracy of the collected data. The data collection also needs to factor in a degree of flexibility; for example, a system that is very rigid and limits a small data range in classifying "good driving", is likely to be unpopular with drivers. Drivers would like to be forgiven for small mistakes, so the design of the system needs to be a little flexible. There should also be a level of abstraction designed into the system; drivers prefer that as little of the detailed data be collected as possible. With the right abstraction level, the appropriate data that contains just enough information for processing can be used. Also, drivers prefer to be as anonymous as possible, so that they are not "blamed" for "bad" data. The degree of

anonymity should be designed such that the organisation can still offer a service that is personalised and considered of good quality to the driver.

After the data is collected, it is normally transmitted to the application server of the organisation. The connectivity of the in-vehicle monitoring device needs to be decided; it is generally preferred that there is as much offline processing within the device as possible, and only the critical data and results are sent online. When there is an online transmission of data, the communication channel must be secured with the appropriate technologies, so that it is difficult to be compromised by undesired third parties.

When the data reaches the server, it is then used by the organisation to provide a service. The trust level and reputation of the organisation are important; drivers want to make sure that their information is used by the "good guys". If the organisation has a poor image, for example, having a webpage with a poorly designed layout and little information of the organisation, this is likely to affect the trust levels of the drivers. Organisations should also tell drivers how they are going to use the data, as much as possible. Finally, there should be privacy and security policies in place to protect the driver, and this should be communicated clearly to the drivers to improve trust.

Throughout the whole chain of data collection, transmission and receipt, drivers appreciate having control of how the data flows. There can be different levels to this: a minimal way is simply to let the drivers know what is happening to the data. This provides a degree of transparency and improves the trust level of the drivers too. A better way is to provide tools to the drivers, much like MyData, that allow them to control on demand, when the monitoring starts or ends, and what

type of data is to be collected. The tool also gives drivers autonomy to decide where the data goes to. For example, he can select his preferred service provider to receive the data. On the service provider side, there can be tools that enable the drivers to decide how the data will be used. For example, a driver may prefer that his data is used just for evaluating a benchmark of his discount level in his insurance, before deciding whether usage-based insurance is the right product for him.

5.2.3 Overall system design for organisations

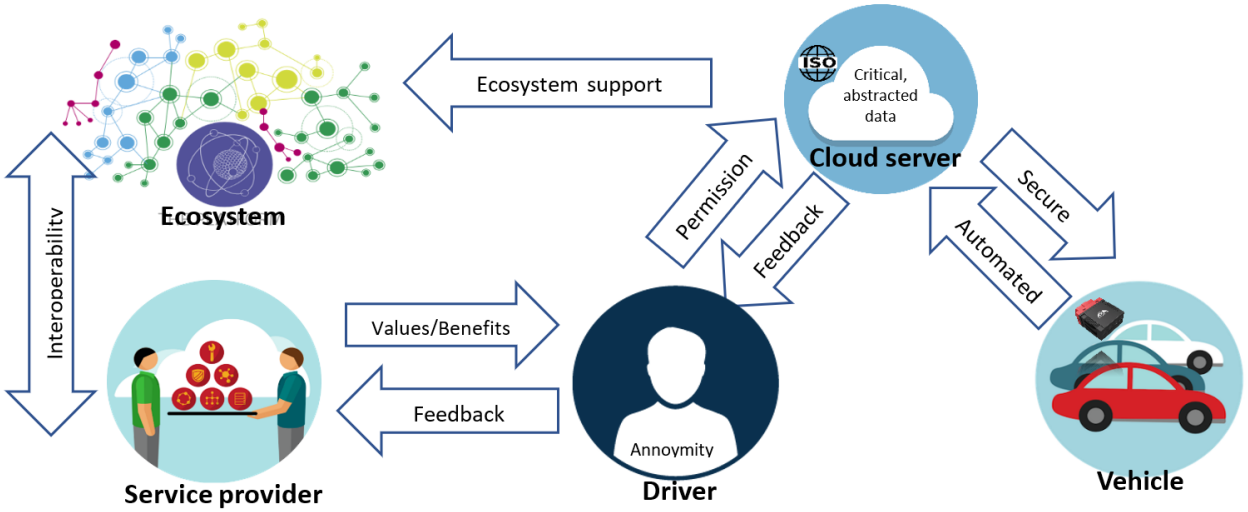

Figure 11: Recommendations for overall system design

Figure 11 shows a proposal of an overall system design for organisations, when they design a product or service using in-vehicle monitoring. Table 17 below presents the recommendations between the different actors in this proposal.

Table 17: Details of recommendations to overall system design

Interaction of Actor(s)	Recommendation
Driver	The driver's identity should have minimal details, as close to anonymity as possible.
Service provider to Driver	The service provider should communicate clearly, the values and benefits of using its product/service to the driver, who will be monitored. The service provider constantly learns how the driver benefits from the system, and adapts the service based on the feedback.
Cloud server	The cloud server that stores the data collected from the monitoring application, should store on critical data needed for providing the service. The details of the data should be as abstracted as possible. The cloud application should adhere to open industry standards and privacy laws.
Vehicle to Cloud server	The data collected by the monitoring device installed inside the vehicle, should be transmitted to the cloud server, via a secure channel. The process should be automated, with little or no human intervention, to enhance the level of security and privacy.
Driver to Cloud server	The driver should have some degree of control of the application in the cloud server. The driver should be able to give permission on the type of data collected, especially location data, and to know the movement of the data.
Cloud server to Ecosystem	The application on the cloud server should adhere to open standards, so that it can be supported by third party's applications in the ecosystem. This allows flexibility and choice to the drivers, to select the best service provider and move their data around.
Ecosystem to Service provider	There should be a high degree of interoperability in the technical design of the monitoring applications, so that the entire ecosystem can compete and grow together to provide appealing services to the drivers.

5.2.4 Marketing recommendations for organisations

From the interviews of the stakeholders, there are 5 points of recommendations for the marketing of in-vehicle monitoring products and services:

(1) **Have clear and simple communication to the drivers**. The message should focus on the benefits, instead of the monitoring. Short term benefits should be especially highlighted. The use of the monitored data should be clarified, especially if law enforcement agencies or government are involved. The marketing campaign can also help the user to visualise how it works, using simulations and tangible examples.

(2) **Build trust with relationships**. Discussions about trust issues should be facilitated and organisations can promote transparency by letting customer know what tools are available for their privacy control, and how the service is compliant to privacy laws. Word-of-mouth marketing by peers and trusted stakeholders, is also useful, especially for service providers who already have a loyal user base.

(3) **Have a customer-centric engagement**. Engage the most active users in the marketing channel that they use the most. Face-to-face marketing has been highlighted to especially useful among professional drivers. Perform targeted information campaigns that focus on the user with the most pain or most gain from the service. Consider the drivers' evolving needs, target their emotional core, and be aware of the social trends.

(4) **Educate the users**. There are different levels of education, ranging from "less is more", to targeting users who do not care so much about privacy. Demystify the fears from movies and internet. Explain to the drivers how the monitoring works and why certain features are

needed. This type of training is especially useful for professional drivers, who are often the public face of their companies.

(5) **Consider the ecosystem of stakeholders**. The MLP theories can be applied to the ecosystem map: at the niche level, companies which want to use in-vehicle monitoring in their products and services, should continue to expand their social network to build a more stable base (Figure 12). This may be achieved by increasing the communication among the companies and organisations through events and seminars. At the same time, these companies should constantly reach out to the drivers at the regime level and learn their needs and wishes, while consistently articulating the vision of the benefits of in-vehicle monitoring at the landscape level, through targeted marketing campaigns and branding.

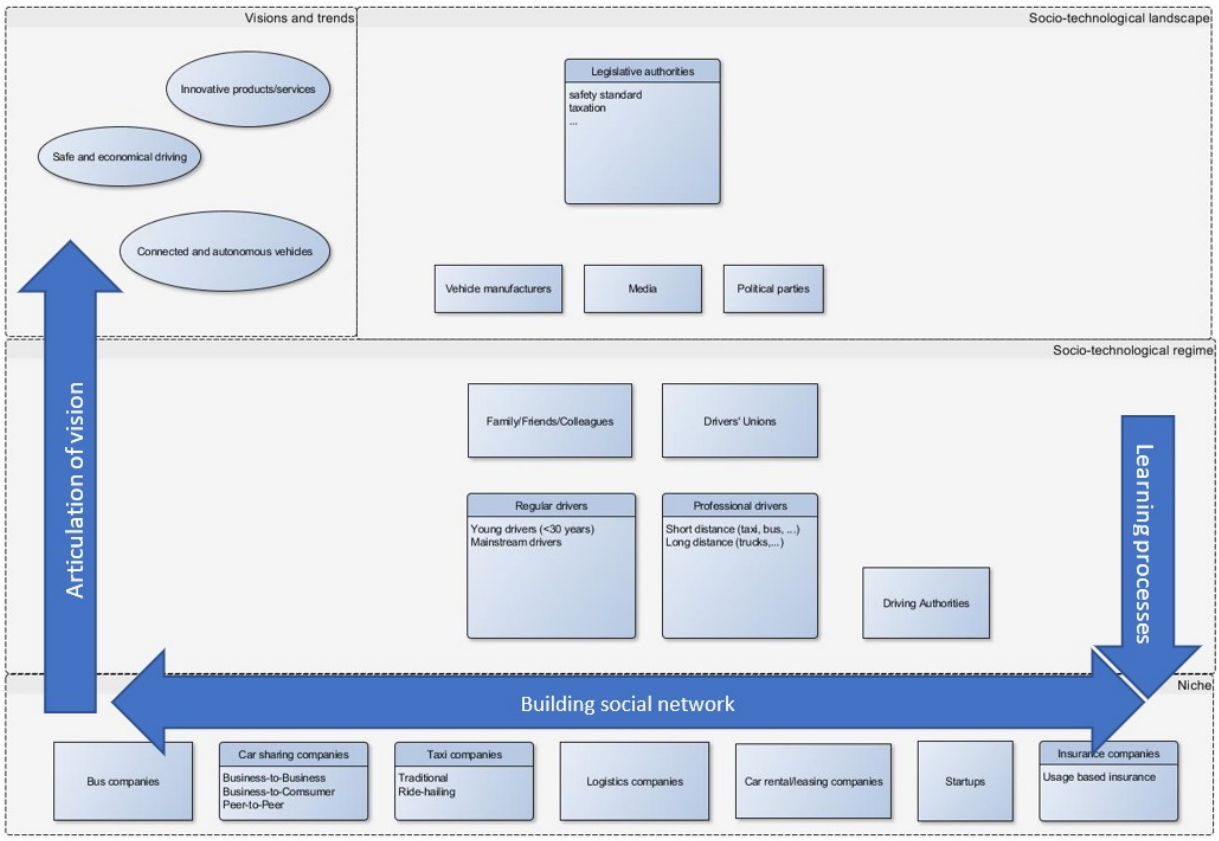

Figure 12: Recommended activities between stakeholders in ecosystem

For most of the drivers, their perception of "in-vehicle monitoring" is a simple feedback system that monitors the status of the car, such as the engine condition, fuel level, etc.… Most of them have not heard or read much about in-vehicle monitoring, but when I further described it more to them, they are concerned about issues like hacking (data being accessed by strangers), tracking (especially on location) and data being used for explicit marketing, where their personal data is sold as a product to organisations. These concerns can be used as initial topics to target in a marketing campaign.

We can apply Bannister's 7-steps communication framework to in-vehicle monitoring to form recommendations for marketing communications with in-vehicle monitoring products and services (Table 18):

Table 18: Recommended communication framework for marketing

Step	Action	Application
1	Information	Prepare the marketing story with initial topics on privacy and trust.
2	Involvement and communication	Involve the stakeholders in the MLP ecosystem, especially drivers and media.
3	Packaging	Design the marketing campaign in an aesthetically pleasing package.
4	Selling the benefits	Focus more on the benefits of the in-vehicle monitoring, not the features.
5	Adopt controversial policies in stages	Give sufficient time for drivers to understand and absorb the information.
6	Consistency between different measures and policy sector	Work with the different companies and transportation agencies to achieve consistency.
7	Adaptability	Adapt the marketing topics, when more is learnt from the drivers.

5.3 Evaluation of the study

Through this study, the main research question of the influencing factors of drivers' acceptance of in-vehicle monitoring have been answered. In addition, practical design considerations for organisations are proposed. Here, we evaluate the research methods used, and discuss the effectiveness of these methods and how it can be improved.

5.3.1 Research design and methods

The research design uses a research framework that is formed through various theories in the literature reviews. This provides an efficient start to form guiding topics for the study. However, this approach is deductive and it limits the scope of input for the data collection. If I am a more experienced researcher, I may adopt a more open-ended, inductive approach that may lead to new findings on the research topic.

The main method used in this study is a qualitative research. Referring to Maxwell's (2009) five intellectual goals for qualitative research described in Chapter 3.1.1, this study enables us to understand the drivers' meaning of using in-vehicle monitoring systems, as well as understanding the context why some drivers do not want to be monitored, due to privacy concern, etc... The processes of which events and actions took place are also well understood, for example we now know that poorly-planned marketing efforts led to a public rejection of an in-vehicle monitoring project. However, we have not generated new theories, nor prove the causality of why drivers accept in-vehicle monitoring systems; we just understand the influence of certain factors. To further study causality, the identified factors must be validated by a quantitative research with a larger sample size of drivers.

5.3.2 Data collection

We used semi-structured interviews as a tool for data collection. This has been effective to solicit responses from drivers and organisations, towards questions that challenge them on the concept and use of in-vehicle monitoring, and subsequently coding and categorising their input. However, this is just scratching the surface of a deeper study; the data collection was done with a very small sample size, with drivers of a limited age range. The inputs from the drivers come without them knowing or experiencing much of in-vehicle monitoring, as the concept is relatively new to them. If the sample size is increased, we can test our research theories more. For example, the data collection can be extended to include more middle-aged drivers, to further research on TAM's perceived ease-of-use as a factor influencing drivers' acceptance of in-vehicle monitoring.

5.3.3 Data analysis

The main use of thematic network analysis has been very effective to identify and categorise the codes from the semi-structured interviews, into factors influencing drivers' acceptance of in-vehicle monitoring. At the same time, I feel that narrative analysis is also a good analytical tool to bring out information from the drivers that is contextually related to in-vehicle monitoring, even if it does not directly answer the research questions. The information learnt from narrative analysis helps in the practical considerations of the design of an in-vehicle monitoring system. For example, we learnt that adaptive cruise control is the favourite feature of many drivers, and the design of an in-vehicle monitoring system can benefit from implementing certain attributes of adaptive cruise control.

5.3.4 Research procedures

The main research procedure involved conducting semi-structured interviews with 11 drivers and 8 organisations. While the interviews provided a lot of information, a workshop is good to double-check the drivers' inputs with organisation stakeholders. Servoped had planned to conduct a seminar during the summer of 2017, where automotive-related organisations are invited to speak on topics related to in-vehicle monitoring. My original plan includes facilitating a workshop in the seminar, where the participants discuss and brainstorm on an ideal automotive product or service that uses in-vehicle monitoring. I wished to use the points of discussion as a qualitative input on the business consideration of developing an in-vehicle monitoring product or service. However, due to time commitments of the participants, many were unable to attend the summer seminar. The seminar was postponed to autumn and the topic was changed thereafter. Due to time consideration for this study, I decided to drop the workshop from my plan. However, the input of the workshop would have been useful.

One challenge of conducting the interviews was that there is no common picture of an in-vehicle monitoring system to the drivers. Therefore, their inputs are based on whatever they think an in-vehicle monitoring system is. It may be better to design a prototype and explain its features clearly, so that the inputs from the interviewees are consistent with what they understand in-vehicle monitoring to be.

5.4 Conclusion and future study

The thesis offers a starting reference that allows automotive-related companies to design products that involves in-vehicle monitoring with bigger chance of a successful adoption. Even though they do not form majority of the identified factors (20%), I think it is worthwhile to further investigate the following topics for a more comprehensive understanding:

- The driver's trust of in-vehicle monitoring systems (TAM with Trust)
- The perceived ease-of-use (TAM) and complexity (DoI) of the in-vehicle monitoring system, and how it affects the drivers' acceptance.
- The impact of communication channels and time (DoI), on the marketing efforts for an in-vehicle monitoring system.

Some other future researches that could benefit this study are:

- Design a prototype of an in-vehicle monitoring system and get a larger sample size of drivers' feedback of its usage.
- Conduct a price research on what is the sweet spot of the willingness of drivers to pay for an in-vehicle monitoring device, versus the benefits that they get.
- Examine existing in-vehicle monitoring services that are appealing to drivers.

As discussed with one of the organisation, the ultimate questions to answer are: "Why will drivers pay to be monitored in their vehicles?", "How do we sell these devices and services to drivers?".

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Appendix 1: Interview questions for drivers

1. General
    - Age
    - Occupation
    - Years of driving experience
    - Vehicle

2. Tell me about the last time you were driving.
    - What features in the vehicle do you find most useful?
    - What is important to you during the drive?
    - What do you think can enable you to drive better?
    - What do you think can make you enjoy your drive more?

3. Tell me about the last time you have been monitored for some activity.
    - How do you feel about it?
    - What was done to the collected data?

4. What do you understand by "in-vehicle monitoring"?
    - Tell me about the last time you have been monitored when driving a vehicle.

Topics of interest	**Questions to dig deeper with "Tell me more"**
Type of Monitoring	What was being monitored?
Stakeholders	Who uses the information being monitored?
Voluntariness	• How did you get started in using in-vehicle monitoring? • Were you consulted/informed of the monitoring?
First impression	• What was your first impression of using in-vehicle monitoring? • Why do you decide to continue using it?
Ease of use	• How is the performance of the monitoring system? • How do you interact with in-vehicle monitoring? • How do you prefer to interact with it?
Control	• How much control do you have over the monitoring? • How much control do you think you should have?

Feedback	• Do you receive feedback from in-vehicle monitoring? • What kind of feedback would you like to receive?
Behaviour change / Observability	How do you think it changes the way you drive?
Opinions (Attitudes)	• How do you feel about in-vehicle monitoring? • What are your concerns over the monitoring?
Performance tracking	How do you feel about in-vehicle monitoring to track your driving performance?
Perceived usefulness	How do you think the in-vehicle monitoring helps you?
Perceived risk	How do you think the in-vehicle monitoring hinders you?
Perceived enjoyment	How do you think in-vehicle monitoring can make you enjoy your drive more?
Perceived innovativeness	How do you feel about the technology of in-vehicle monitoring technology?
Preferred Use-case	How do you prefer to use in-vehicle monitoring?
Beliefs	• What do you think is being monitored? • Why do you think this is being monitored? • What have you heard/read about in-vehicle monitoring?
Social influence (Subjective norms)	Who do you think might be interested in the information? How do you think this information affects you socially? Do people around you use in-vehicle monitoring? • How do they use it? • Why do they use it? • What do you think of them?
Secondary stakeholders	• Who affects your decisions in life? • Who do you trust with your information?
Commercial use-case	How do you think companies can use in-vehicle monitoring to benefit you?
Trust/Accuracy	• Do you trust the in-vehicle monitoring system? • How do you think the in-vehicle monitoring can make you trust it more? • Do you trust the companies that collects this information? • How do you think companies can make you trust them with your information?
Branding	• What is the type of branding message that you like? • How do you like this message to be delivered? • What type of message/advertisement do you think is not appealing?
Reward and meaning	What types of rewards are meaningful to you? • Quantity, frequency? • Penalties?
Common questions	• What might cause you to use even more in-vehicle monitoring? • What might cause you to stop using in-vehicle monitoring?

Appendix 2: Interview questions for organisations

1. General
    - Age
    - Role and responsibility of interviewee

2. Organization in general
    - What is the main product/service provided by the organisation?
        - Why is such a product/service important for the organisation?
        - Why is such a product/service valuable for the customer?
    - What is important to your organisation?
    - How does your organisation learn customers' needs?
    - How does your organisation promote its products/services to the customers?

3. In-vehicle monitoring

Guiding topics	**Questions**
Type of monitoring	• What is being monitored? • Why is there a need to use in-vehicle monitoring?
Stakeholders	Who do you collect the information from?
Voluntariness	• How much influence do customers have over the monitoring? • What is the organisation's perspective of customers who do not want to be involved in the monitoring?
First impression	• How do you make a good first impression of in-vehicle monitoring to the customer? • What are some of the common feedback from customers? • Why do customers continue to use it?
Ease of use	• How is the performance of the monitoring system? • How does your customer interact with in-vehicle monitoring?
Control	• What control does the customer have over what is being monitored? • How much control do you think the customer should have?
Feedback	What kind of feedback from in-vehicle monitoring is given to the customer?
Behaviour change/Observability	How has in-vehicle monitoring changed the way your customers drive?
Opinions (Attitudes)	• How do your customers feel about in-vehicle monitoring? • What do you think their concerns are?

Performance tracking (if applicable)	What do you think about the performance tracking of your customers?
Perceived usefulness	How do you think the in-vehicle monitoring helps your customer?
Perceived risk	How do you think the in-vehicle monitoring hinders your customer?
Perceived enjoyment	How do you think in-vehicle monitoring can make your customer enjoy their drive more?
Perceived innovativeness	What is innovative about your in-vehicle technology?
Preferred Use-case	• How do you think your customers prefer to use in-vehicle monitoring? • What feature related to in-vehicle monitoring do you think your customers find most useful?
Beliefs	• What is the customer's perception of your in-vehicle monitoring? • How do you get feedback about their reception/perception?
Social influence (Subjective norms)	• Who else do you think might be interested in the information? • How may this information be used socially? • How do you monitor the social impact of the in-vehicle monitoring to your customers?
Secondary stakeholders	• How do your competitors or partners use in-vehicle monitoring? • Who are the important stakeholders in your business?
Commercial use-case/	• How do you think your business can benefit more from the use of in-vehicle monitoring? • What do you think can be done to attract more customers to use in-vehicle monitoring?
Trust/Accuracy	• How do you ensure that the monitored information is accurate? • How do you promote trust in your customer with the information?
Branding	• How does your organisation promote in-vehicle monitoring products? • What type of branding is most effective for your business?
Reward types and meaning	What types of rewards are given by your organisation to your customers? Quantity? Frequency?
Common questions	• What might cause your customer to use even more in-vehicle monitoring? • What might cause your customer to stop using in-vehicle monitoring?

Appendix 3: Interview questions for transport and research agencies

1) What is the role of the organisation when it comes to connected cars and in-vehicle monitoring?
    - What are the goals of the organisation?
    - What is done to achieve the goals?
    - What are the challenges?
    - How do you think the challenge can be solved?

2) How is the expertise sought about in-vehicle monitoring?
    - Who are the important stakeholders?
    - Are there any partnerships? How does the partnership work?
    - How does the organisation reach out to drivers?

3) What are some projects related to in-vehicle monitoring that your organization has piloted?
    - What are the results?
    - What are the challenges?
    - What are the future opportunities?

4) Referring the reception of past-vehicle monitoring project and research studies done,
    - What were the challenges?
    - What can be done better next time?
    - What are the future opportunities?

5) In your opinion, what are the factors the affect drivers' acceptance of in-vehicle monitoring?
    - What are their concerns?
    - What might encourage them to use more?
    - What make cause them to stop?

6) In your opinion, what should organization consider when implementing products/services with in-vehicle monitoring?

Appendix 4: Interviewed stakeholders

SN	Person	Occupation	Type
1	JS, Male, 23	Part-time truck driver	Professional, long distance driver
2	SP, Female, 27	Bioscience researcher	Regular, young driver
3	GH, Male, 27	Business development	Regular, young driver
4	MI, Male, 30	CEO	Car sharing company
5	JP, Male, 29	Entrepreneur	Regular, young driver
6	TP, Male, 32	Data Manager (Risks)	Auto-financing company
7	KV, Male, 51	Part-time taxi driver	Professional, short distance driver
8	LP, Male, 27	Part-time delivery driver	Professional, short distance driver
9	NS, Male, 36	IT support	Regular, mature driver
10	JH, Male, 22	Full-time delivery driver	Professional, long distance driver
11	RK, Male	Advisor	Transportation agency
12	IH, Male	Project Engineer	Research agency
13	JM, Male,22	Full-time truck driver	Professional, long distance driver
14	RA, Male, 41	Bus driver	Professional, short distance driver
15	SM, Male	Consultant	Transportation agency
16	MR, Male	Implementation Manager	Professional drivers' union
17	SH, Male	CEO	Mobility company
18	TC, Male	Project Engineer	Research agency
19	VL, Male	Automotive educator	Regular, mature driver

Appendix 5: Coding and thematic network analysis

Codes	Basic themes	Organising themes	Global themes
Environmental impact	Environmental	Acceptance by altruism	Supporting the driver's ideals and morals
Penalty system	Public good		
Constructive use of data			
Public safety			
Increase public trust			
Improvement of car	Technology improvement		
Data used purely for commercial marketing	Over-commercial use	Resistance by manipulation	
Data used inappropriately for wrong causes	Bad use of data		
Using data to manipulate people			
Unknowingly monitored for free service	Knowingly ignore	Acceptance by awareness	Awareness of the technology
Not affecting physical life			
Being trained about system	Knowledge		
Data movement is known			
Younger drivers	Savviness		
Fear of new things	Fear	Resistance by ignorance	
Adjustment period is too short	Getting used to things		
Lack of knowledge about system	Ignorance		
Appealing business case	Business and Services	Acceptance by business benefits	Comparing benefits and costs
A fair exchange			
Enabling car-sharing			
Clear business case			
Part of receiving free service			
Lead to better service			
Service from private companies			
No business need		Resistance with no business benefits	
Protection of assets	Economics	Acceptance by economic benefits	
Protection of driver's interest			

Getting value from the system	Feeling the value	Acceptance by feeling the value	
Value of benefits outweigh concerns			
Monitoring based on driver's needs			
No benefit in return		Resistance with no feel of value	
Mismatch of benefit vs cost			
Not convinced by benefits over costs			
Unclear idea of benefits			
Giving driver direct feedback	Receiving knowledge	Acceptance by benefit of knowledge	
Counter checking claims			
Finding places of interests			
Knowing car health better			
Proving responsible driving	Validation of performance	Acceptance by validation of driver	
Data sharing among employers			
Evaluating driver's performance			
Monitoring tasks			
Penalty system	Reward vs Penalty	Resistance by penalty system	
Reward is not attractive			
Safety risk	Safety	Resistance by safety risk	
Community-based information sharing	Efficiency	Acceptance by increased efficiency	
Active incident reporting to drivers			
Convenience			
Cooperation between drivers			
Increasing efficiency			
Driver guidance			
Monitoring on crowded roads			
Getting the job done in shorter time			
Free incident reports on the road			
Cost to drivers	Cost	Resistance due to cost	

Cost to small companies			
Unwilling to pay for equipment			
Monitoring for purpose to collect money	Money-collection		
Part of the job	Having no choice due to environment	Acceptance by practical choice	Autonomy of driver
Enforcement by law			
Monitoring on demand	Control of data	Acceptance by having control	
Transparency of data use			
Data movement known by user			
Desire for autonomy	Driver's need for control	Resistance by wanting autonomy	
Driver knows better than system			
Driver thinks he know better than system			
No control over monitoring			
EU regulation pressure	External pressure		
Increased stress to driver			
Promoting unhealthy competition			
Novice drivers want to have fun	Driver's need for freedom		
Easy to use	Ease of use	Acceptance by easy interaction with system	Design of system
Adaptive monitoring to environment			
Bad usability	Poor ease of use	Resistance by difficult usage	
Lack of design aesthetics	Unattractiveness		
Too frequent reminders	Annoyance		
Over-tracking			
Owns car fleet for business	Owning the risk	Acceptance by risk of ownership	Ownership
Owns own car			
Vehicle does not belong to driver	Not owning the vehicle	Acceptance by responsibility	
Part of receiving a service			
Driver's personal car	Drawing the line of monitoring personal property	Resistance due to personal items	
Only result of analysis is transmitted, not raw data	Abstraction of data	Acceptance by protection of privacy	Privacy

Data anonymity	Not revealing source of data		
Information used by the driver only	Offline processing		
Secure transmission of data	Protection of data	Acceptance by security of data	
Encrypted data			
Heavy penalties for companies who break data privacy rules	Protection by policies		
Affects personal life	Intrusion	Resistance by privacy intrusion	
Big brother surveillance			
Direct link to law enforcement			
Fear of information being used against user			
Government monitoring			
Information is seen by unknown people without user's permission			
Location tracking			
Recording driver's actions			
Recording driver's image			
Other less intrusive ways of collecting tax			
Car connected to internet	Online risk	Resistance by security risk	
Data security risk			
Fear of car being hacked			
No worries if driver is driving properly	Good driving behaviour	Acceptance by trusting system	Trust
Trustworthy organisation is collecting data	Trusting the organisation		
Data accuracy	Trusting the collected data		
Flexible system that forgives driver sometimes			
Human monitoring as a double check			
Allowing clarification of collected data			
Causing mistrust among drivers	Promoting suspicions	Resistance by lack of trust	

Inaccurate scoring	Data with low accuracy		
Monitoring by external organisations	Untruthful organisations		
Secretive companies			
Lack of transparency for public services	No clear information access		
Bad input from critics	Bad reviews	Resistance by influence of media	Media and marketing
Bad publicity from media			
Influential media setting negative tone			
Poor general public opinion	Bad public opinions		