Universiteit Leiden

ICT in Business and the Public Sector

Explaining driving behavior in a connected car

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MASTER'S THESIS

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"The first step is to establish that something is possible; then probability will occur".

Elon Musk
CEO of SpaceX and CEO of Tesla, Inc.

Contents

1. Introduction

It is to be expected that the automobile industry will transform in the coming years (Swan, 2015). KPMG expects that this is due to innovation and the fact that more people inhabit the planet and become increasingly older. With innovation KPMG points out to renewable energy sources, new forms of transportation like Uber and last but not least self-driving cars and connected cars (KPMG, 2018). Uber is an American company that provides a new form of taxi services. Next to taxi services Uber provides application- and payment services (Bloomberg, n.d.). The connected car vehicle is real time connected to its surroundings by use of the internet. In that way the vehicle generates and transmits data. This data can be used by applications that for instance communicate traffic centres or smart devices. The generation and transmitting of data could possibly raise road safety, security and or privacy concerns; the awareness of being “under surveillance” could potentially affect behaviour of drivers in a car that uses the connected car technology (Shaw, 2014).

A connected car produces, receives and transmits huge data volumes. These volumes can reach up to 4 terabyte per day (Future of privacy forum, 2019). Until now, digital technology in cars has focused on the optimisation of functions and performance of the car. Today, this same digital technology is changing towards the connection with the environment of the car. For the car users, the in-car experience becomes more and more the focus. The connected car has the capability to bring optimization to its own operation and maintenance. These features provide support to the driver and passengers. By using a large number of on-board sensors and an permanent internet connection, a connected car is able to do so (Habeck et al., 2014).

Next to the in-car experience, improvements in driver safety, comfort and convenience is increasing by connectivity. But this increased connectivity may also call for new data security mechanisms to ensure the integrity of automotive systems, while protecting consumers from the risk of intentional cyberattack or theft of personal data (Infineon, 2014). Personal data can be described as information that can be related to a person or can identify a person (European Commission, What is personal data, 2002). Data security and privacy concerns might be related to a number of topics, such as: “politics, regulation, economics, technology adoption and logistics”. In light of a connected car, topics of privacy and security (of –personal- data) might become a big concern for people. To some people the phenomena of big data makes them worry (Serrato, n.d.). “Big data is larger more complex data sets that are so voluminous that traditional data processing software can’t manage them” (Oracle, 2001). Big data techniques require access to our information, this information can be personal of nature. This puts pressure of the relationship of convenience and our privacy (Tech republic, 2016). The European Commission supports equal data access to data from connected cars (European commission, 2020), whereas the accessible data is depersonalised or non-personal. The European Commission described this access in a ‘Data-economy’ policy. Together with CECRA, an alliance of the automobile industry (CECRA, 2020), the European Commission establishes an open telematics platform with ready to use, standardised and secure data. The open telematics platform should provide connected car users with a technical possibility to control data sharing with third parties and, by doing so, assure them of safeguarding of their data and privacy. Concerns on data and privacy might influence human behavior. If the awareness of being ‘watched’ influences human behaviour, perhaps a technical solution for permissioned control over data or the availability of a legal framework for the privacy protection could provide a solution?

1.1 Problem definition

In a continuously connected car, the driver's behavior could be monitored by third parties like the government or your car manufacturer, or your insurance company. For instance speeding on the highway, that potentially could result in a fine, but can now also have an effect on the price you pay for your car insurance (not obeying the rules could result in damage and thus a higher premium on your insurance) or even your health care premium (speeding could result in an accident that potentially could harm you). Furthermore the possibility of predicting or influencing ones behaviour based on what you do, did, or liked, by using data flows linked with machine learning and predictive modelling (Domingos, 2012) might also subconsciously affect people in their behaviour (the navigation system in your car could direct you along your favourite stores and in that sense trigger a purchase you didn't plan).

Since the driver's behavior in a connected car can be monitored by third parties, the awareness of being 'watched' could potentially influence the driver's behavior; this monitoring mentioned, may affect the driver's privacy. Questions that rise are; what triggers our behavior intension if we are aware of this potential monitoring? Are people willing to share their data if they have that option? And if so, what kind of data? In case of connected car technology there are two kinds of data to be shared, technical- and private data. The technical data consist of information on the technical state of the car, like a sufficient amount of oil or functioning brakes. Personal data consist for instance of a multimedia playlist, route information or personal messages transmitted from the car. Insurance companies offer discounts (Verbond van Verzekeraars, 2016) on car insurance premiums if drivers allow the insurance company real-time access to their car data. Could this be the incentive that would convince drivers to agree on this type of data exchange and possible compromise on their privacy?

1.2 Research gap and research question

A majority of research that has been done, is on the connected car technology itself, on the topic of safety, connected car and its effect on traffic (in terms of less congestion on roads) and the topic of privacy. This leaves a more or less a green field situation for my research on behavioral beliefs towards connected car regarding privacy (personal-data) and data control, based on the theory of both planned behavior and the information panopticon. The question is what motivates behavior, in particular what motivates people towards the adaptation of new technology, in this case a connected car? If the awareness of being 'watched' potentially influences behaviour, perhaps a technical solution that empowers people by providing permissioned control over their data or the availability of a legal framework that protects and safeguards ones privacy, influence behavioral intensions towards connected car. A theoretical model to investigate the possible influence of human behavior in a connected car may be found in the theory of planned behaviour. The theory gives an explanation and a prediction on multiple human behaviors like for instance gambling (Ajzen, 1985, 1987). In general it states that people's actions are based on their motivation and their ability. The theory states that human action is steered by three kinds of beliefs:

- "Behavioral beliefs (about the likely outcomes of the personal behavior and the evaluations of these outcomes);
- Normative beliefs (beliefs about the normative expectations of others and motivation to comply with these expectations);
- Control beliefs (beliefs about the presence of factors that may facilitate performance of behavior, the ability of a person to handle or perform a task)".

A different explanation for influence on human behavior in a connected car may be found in the information panopticon. It represents the influence of surveillance on human behaviour where by the use of technology like for instance CCTV cameras, people are observed and controlled (Bentham, 1995). The introduction of surveillance by CCTV cameras is a good example. Also the monitoring of internet usage by internet service providers can be put under the term panopticon. The word panopticon comes from the design of a prison building. This prison was invented by the Englishman Jeremy Bentham (Bentham, 1995). The building allows a prison guard a widespread view on the prison population, without this population knowing they are monitored by the guard. On the upside there are possible benefits in terms of service improvement and declining costs. On the downside; as a larger amount of data on for instance behaviour or whereabouts is collected, the concerns on privacy may potentially grow. These questions and assumptions lead to the following research question and sub-questions:

Main research question:

"To what extent can the theory of planned behavior explain behaviour intension towards connected car regarding privacy and data control?"

Sub research questions:

"What are the normative beliefs when driving a connective car?"

"Will the availability of 'privacy protective legislation' on data gathered and distributed from a connected car influence normative beliefs towards connected car?"

"Can the availability of a technical solution to manage and control data gathered and distributed from a connected car, like an 'open telematics platform' influence control beliefs towards connected car?"

"Will the current capability level of connected car technology allow Rijkswaterstaat to use retrieved data from connected cars to further safeguard, manage and control traffic on Dutch highways?"

1.3 Snapshot of the theoretical framework and the methodology

The theoretical framework used for this thesis is based on a combination of the theory of planned behavior (Ajzen, 1991) and the information panopticon (Bentham, 1995). The information panopticon is about the influence of surveillance on human behaviour; Information and communication technology (ICT) is used to observe and control humans. One could state that Bentham's original idea of the prison panopticon (in order to influence human behavior) has a parallel to the theory of planned behavior, where a person's attitude and opinion combined with his or hers perceived control of behavior plus the subjective norms of society influence a person's behavioral intention that ultimately leads to certain behavior or actions.

The research design for my thesis is blended and consists of exploratory research combined with a case study. A quantitative survey among individuals will be used to gather data that is retrieved from scaled questions.

1.4 The significance and social relevance of this study

The connected car technology potentially raises security and privacy issues and could affect driving behaviour. The 'big brother is watching you' awareness among drivers might influence their driving behaviour. This could potentially be alarming in terms of privacy and (road-) safety. It could also provide benefits to society in terms of efficiency, reliability and road safety.

This study will be significant to both the general public and ultimately the ministry of Infrastructure and Water management and its executive agency Rijkswaterstaat. The general public will benefit in terms of the awareness that is created by this study on the topic of (personal-) data and privacy; a connected car generates different types of data, generated by a variety of data sources which are distributed by different data flows. Data that is generated by connected cars is about the use of the car (like destination, route, communication and infotainment). It can contain sensitive and personal information about a person, like driving routines and places of interest. Besides being identified, a person's religion, political preference, sexual orientation or relationships can be revealed to third parties. This information can potentially become useful and even misused when matched with information out of existing databases, both private and governmental. It is therefore important to create not only (legal) protection but also to create awareness. The ministry of Infrastructure and Water management and Rijkswaterstaat (as a part of this ministry) will benefit in terms of knowledge on both the topic of adaptation of new technologies by the general public and the possibilities to safeguard gathered data from misuse. Rijkswaterstaat is becoming increasingly dependent on connected car data, since it is its policy to bring the infrastructure components (for instance; road signs, route information, congestion solutions and overweight solutions) that are now outside of the car, in a smart way inside the car (Ministerie van Infrastructuur en Milieu, 2016). Data received from in-car solutions will be used to further safeguard, expand and manage & control traffic on Dutch highways (Jonkers, n.d.). The knowledge provided by this study will support both business goals of Rijkswaterstaat as well as strategic goals as well as innovative projects such as 'smart mobility'.

2. Theoratical framework

The theoretical framework used for this thesis is the theory of planned behavior. One could state that behavioral achievement depends on behavioral beliefs, normative beliefs and control beliefs. "According to the theory of planned behavior human action is steered by behavioral beliefs, normative beliefs and control beliefs" (Ajzen, 1991). If a positive attitude towards all three beliefs is present, the theory predicts a high probability for a positive outcome towards a certain behavioral intention that will lead a certain behavior. It is therefore of interest to study what drives a person's intent.

Next to the theory of planned behavior, the information panopticon is studied. The information panopticon is about the influence of surveillance on human behaviour. By the use of technology like for instance CCTV cameras, people are observed and controlled (Bentham, 1995).

The panopticon can be seen metaphorically if the central tower concept by Jeremy Bentham is compared to monitoring in a connected car. Is our behaviour in a connected car influenced if we are aware of a big brother watching us, similar to Bentham's panopticon used in a prison to influence the behaviour of inmates?

2.1 Theory of planned behavior

In basis the theory of planned behavior is about the belief that a person's behavior depends on the answer to 3 questions:

- What do **I think what will happen** if I do this action? How likely is it that the outcome is favourable versus bad? These are called Behavioral beliefs;
- What **do others think** about my behavior? Do other people expect me to do it and do I care about the opinions of others? These are called Normative beliefs;
- **Do I think I can do it?** What is going to make it easier or harder for me to succeed? These are called Control beliefs.

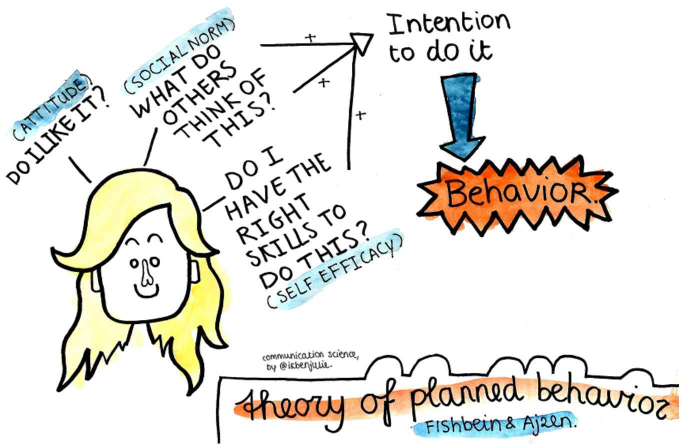


Figure 1: Illustration theory of planned behaviour (ER services, n.d.)

As stated, the theory of planned behavior is constructed out of an attitude, perceived behavioral control and subjective norms. This, according to the theory, influences intention and behaviour:

Concept	Definition
Behavioral Intention	The perceived likelihood of a person carrying out this behavior. Are they likely or unlikely to carry out this behavior?
Attitude	A person's individual feelings and evaluation of the behavior. Do they see this behavior or action as a good or bad?
Subjective Norm	How others in society view this behavior. Do others approve or disapprove of this action?
Perceived Behavioral Control	The individual belief that one has control over a specific action or behavior. Do they believe that they can successfully carry out this behavior?

Source: National Library of Medicine, 2013.

Table 1: concept and definition of the theory of planned behavior (National Library of Medicine, 2013)

The beliefs are displayed in the table below:

According to the theory of planned behavior, human action is steered by three kinds of beliefs:

"Behavioral beliefs - These are beliefs about the likely outcomes of the behavior of a person. The behavioral beliefs produce a favorable or unfavorable attitude toward the behavior;

Normative beliefs - Beliefs about the normative expectations of others and motivation of a person to comply with these expectations. Normative beliefs result in perceived social pressure or subjective norm;

Control beliefs - Beliefs about the presence of factors that may facilitate performance of the human behavior. Control beliefs give rise to perceived behavioral control or the ability to produce a desired or intended result".

Source: Ajzen, 1991

Table 2: three kinds of belief, source Ajzen, 1991

If a positive attitude towards all three beliefs is present, the theory predicts a high probability for the presence of a certain behavioral intention that ultimately will lead to a certain behavior. It is therefore of interest to study what drives a person's intent. Control over a person's behaviour is represented by the six constructs displayed in the table below:

Six constructs represent a person's control over his or her behavior:

- "Attitudes - About the degree to which a person has a favourable or unfavourable evaluation of the desired behavior;
- Behavioral intention - About the motivational factors that influence behavior;
- Subjective norms - About whether most people approve or disapprove of the behavior;
- Social norms - About the codes of behavior in a group;
- Perceived power - About the perceived presence of factors that may facilitate behavioral performance;
- Perceived behavioral control - About the perception of the ease or difficulty of performing desired behavior".

Source: Ajzen, 1991

Table 3: the six constructs, source Ajzen, 1991

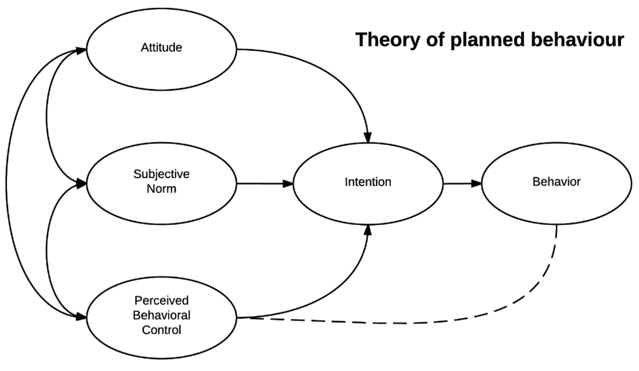


Figure 2: model of the theory of planned behaviour, source: Ajzen, 1991

2.2 Information panopticon

The information panopticon represents the influence of surveillance on human behaviour. "Information and communication technology (ICT) is used as observational tools and control mechanisms by a centralised power" (Bentham, 1995). Surveillance by modern cameras is a good example, also internet service providers who analyse internet behaviour of their customers is a way of panopticon. "The term Panopticon refers to a type of prison building designed by English philosopher and social theorist Jeremy Bentham" (Bentham, 1995). This provides observers with the possibility to observe prisoners without them being aware of this.

Jeremy Bentham was born in 1748 and died in 1832 in London (Stanford encyclopaedia of philosophy, 2019). In 1786 Bentham went to Russia to visit his brother. Bentham was fond of an idea of his brother and took this idea and altered it into the "panopticon", which he described in his book 'the inspection house'. The panopticon is a round designed building and was mend as an institution. This institution can be a school, hospital, mental health institution or (as the most famous example) a prison. An essential part of the panopticon is that inspection is centralised. According to Bentham it would be ideal if people who were institutionalised, were constantly watched by inspectors so that they are encouraged to behave as though they are watched all the time. In this way inmates regulate their own behavior. To do so, a large number of inspectors would be necessary. To avoid this large number of staff, Bentham thought of a next best thing; give the (in case of a prison) prisoners the idea that they are constantly being watched. This was achieved by Bentham by two interlinked elements: 1). the centralised position of a prison guard in the prison, 2). the prison guard must be enabled to watch the prisoners without them seeing him.

According to Bentham this would lead to a situation where the prisoners would have the idea that they were constantly watched. To achieve this, a circular building was designed, with the prison guard in the centre and the cells along the walls.

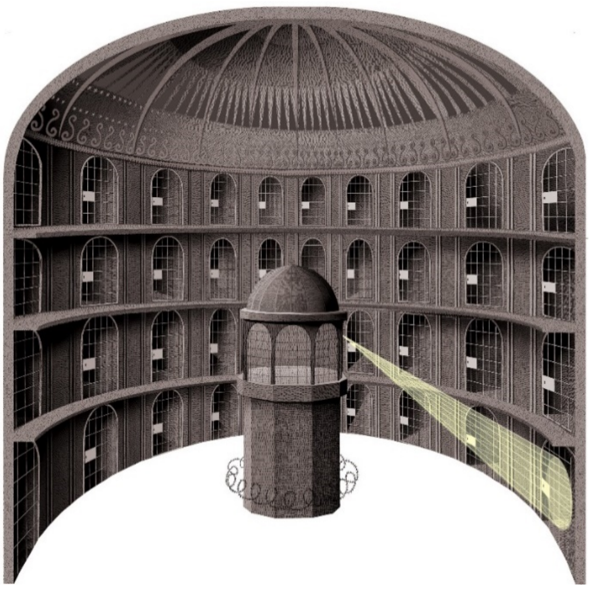


Figure 3: Panopticon prison building, source (New York Times, 2013

This approach could be seen as mechanistic and inhumane. However, one could state the Bentham's panopticon idea is quite similar to the way modern technology is used nowadays to monitor for instance public places, where CCTV cameras are used. In these situations people are also watched without their awareness. Also people's online activities can be monitored watched without their awareness. So in a sense Bentham's panopticon ideas may have become a reality.

To sum up the characteristics of Panopticism, the following points can be made (Aalborg University Denmark, 2007):

- "People who are observed cannot see the observer;
- The people who are observed are told they are continuously being observed;
- There is not much effort put in the observation;
- The surveillance is not aimed at one person;
- This type of surveillance is helpful when studying human behaviour".

In today's world the options for monitoring people to change behaviour is expanding:

- "School systems are able to track progress on student skills and therefor are able to tell who's best;
- Accountancy systems can register human errors and from that measures against personnel can be undertaken;
- Security systems keep track of employees; who has been where, at what time and date. This effects the privacy of staff involved".

The systems above focus on both individual and group behaviour. Subject are mostly not aware of this surveillance.

3. Methodology and approach

3.1 Research methodology

A quantitative research approach will be applicable. A quantitative survey among individuals will be used to gather data that is retrieved from scaled questions. A scaled question is a question that requires people to rate their experience. This approach has been chosen as it is the most applicable and convenient, since my research takes place at my place of work, among colleagues. Next to the availability and willingness to participate from colleagues and the presence of management support, a vast amount of relevant corporate information is available for my research. Finally the research topic matches the corporate interest of my employer.

The following steps are applicable in the process of gathering data:

- Definition of the research question and sub questions: “To what extent can the theory of planned behavior explain behavior intension towards connected car regarding privacy and data control?”

- Collecting and the interpretation of data:

    - A pre-study, where individuals are interviewed;

    - A survey in order to test the relation between dependent and independent variables. The survey data will be collected among a population individuals working for the Dutch government. The sample consists of employees from the Rijkswaterstaat department of traffic management. The targeted group consist of females as well as males, between the age of 18 and 65. The survey will be distributed to- and retrieved from this group by the use of email;

    - A literature and desk study will be conducted. Document analysis will be applied, this involves examining written, visual, and audio documents that already exist;

    - A post-study will be executed to explain the findings of the study. Retrieved data is analyzed and summarized with the help of Statistical Analysis software tooling.

3.2 Research design

The research design for my thesis is blended and consists of exploratory research combined with a case study.

I used an exploratory design because there are no similar or previous studies conducted on the research problem. My goal is to get insight and become familiar with the topic.

My goals of this exploratory research are to:

- Get familiar with the basic details, settings, and concerns;
- Develop understanding on the situation being developed;
- Generate new ideas and assumptions;
- Develop tentative theories or hypotheses;
- Determine feasibility for future studies;
- Get direction for future research and techniques.

Expected results:

1. Gaining background information on my topic;
2. Address my research question(s) (what, why, how);
3. Provides an opportunity to clarify existing concepts.

The case study provides an in-depth study on my research. It is used by me to bring back my research topic to a researchable example. The case study research design will be used to test my theory against reality.

Expected results

1. A detailed analysis of a (limited) number of events and their relationships;
2. Extend experience to what is already known by previous research;
3. Provisioning of detailed descriptions of (a) specific case(s).

4. Connected car and the ministry of Infrastructure and Water management

4.1 Connected car explained

Definition

A large number of definitions on the topic of connected car can be found in literature and in a variety of articles throughout the internet. In my thesis study the definition of connected car by KPMG will be applicable. In its global automotive executive survey report 2017, KPMG states that:

"The connected car is a vehicle that is connected to the environment (often the internet) via a mobile data stream. The car includes a SIM card that enables a data stream from the car to cloud servers that capture the data, but also a data stream from cloud servers to the car. The concept of the connected car also includes vehicles that are connected to each other (V2V) via local range networks" (KPMG, 2017).

Data

According to the KPMG report a connected car generates different types of data, generated by a variety of data sources and distributed by different data flows. To do so a connected car uses telematics. Telematics can be explained as technologies that registers activities in a connected car. The data generated by these activities and events is send via the internet into the cloud on a server where it is stored. Next to generating data from inside the car, a connected car generates data from the environment, like road conditions and actual traffic situations.

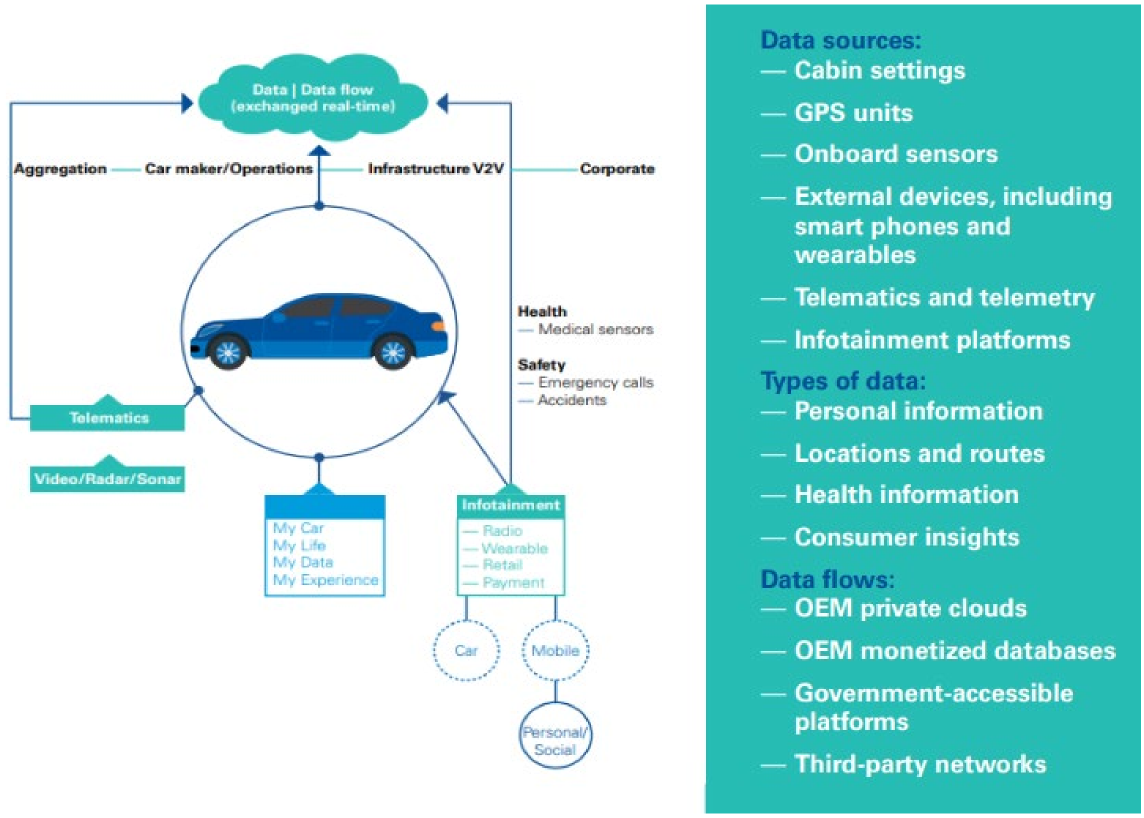


Figure 4: types of data, source KPMG, 2017

Telematics

By telematics a vehicle can be monitored. By applying a vehicle with a GPS system and a diagnostics system, data on the location, the speed and the behaviour of the car becomes available (Techradar, 2012).

Digital user experience

Automakers and tech companies like Apple, Google or Spotify provide a so called digital user experience in connected cars. While the car manufacturers OEM (original equipment manufacturer) gathers car data, tech companies provide entertainment and infotainment. It is expected that the most successful car manufactures are those who are able to combine technologies and services together in a usable and delightful way for consumers (Contentsquare, 2019).

According to KPMG there are a number of key data flows that drive the digital driver experience in connected cars, the four flows are displayed in the graphic below (KPMG, 2016).

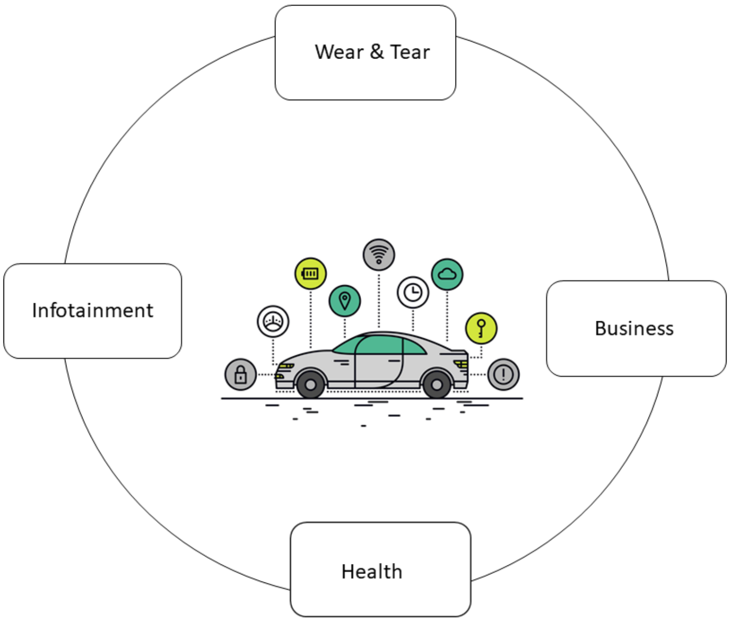


Figure 5: four key data flow, source KPMG, 2016

Wear and tear

On board sensors collect status updates from the connected cars components. The collected information is shared by telematics with car manufacturers, supply chains, car dealerships and repair shops in order to perform maintenance, reserve spare parts, prevent a breakdown of the vehicle or to book an appointment at the garage.

Infotainment

Driver and passenger usage data is collected by dashboard consoles from the connected car. GPS devices collect location data. Telemetry devices connects users to their business, content and providers. The collected data can potentially create business and research opportunities.

Business

Connected cars can connect drivers to their businesses. Workers can work by calling hands-free and connect to the business network.

Health

On board sensors and connected external devices can collect data on so called vital human signs. Via telematics, emergency responses, medical reminders and linkages to healthcare providers, support can be provided to both driver and passenger.

Connection types

A 2015 study at Berkeley University California on connected cars shows that "the telematics control unit is the core component in vehicles that enables the car to connect". The study distinguishes three primary integrations of connected systems; "embedded, tethered and smartphone" (Berkeley University, 2015).

Embedded systems	Tethered systems	Smartphone systems
Embedded systems consist of hardware and software along with a SIM card.	A tethered system is similar to an embedded system, but without a SIM card. The driver has to provide a SIM card, most typically by using a cell or smart phone.	A smartphone system relies on the smart phone of the driver to provide services and applications.

Table 4, connection types, source Berkeley University, 2015

A fourth channel of connectivity is by on board diagnostics (OBD). On board diagnostics is referring to a vehicle's computerized self-diagnostic and reporting capability. OBD systems provide access to the status of vehicle systems. Cars equipped with OBD systems allow drivers to plug-in devices that can access vehicle's data and for instance diagnose malfunctions.

Communication

According to the center for advanced automotive technology (CAAT) communication between the connected car and its environment consist of five ways and is displayed in the figure below (Autocaat, 2016):

V2I "Vehicle to Infrastructure": devices such as sensors collect data generated by the vehicle and provides this information to the infrastructure and, on its turn, infrastructure information is provided back to the connected car. The V2I communicates about safety, mobility and environmental (infrastructure) related conditions;

V2V "Vehicle to Vehicle": Information about speed and position of surrounding vehicles is communicated to the connected car through a wireless information exchange. The goal of V2V communication is to avoid accidents and dissolve traffic congestions;

V2C "Vehicle to Cloud": vehicle to loud enables data exchange of information between the connected car and a cloud system. This enables the connected car to use information from other sources or services like services, maintenance, transportation and smart devices and vice versa;

V2P "Vehicle to Pedestrian": by the use of sensors, information about the connected cars environment is communicated to the driver and to other connected vehicles. Also surrounding infrastructure as well as personal mobile devices can be connected. This enables the connected car to communicate with its surroundings, such as pedestrians and thereby improve road safety and mobility;

V2X "Vehicle to Everything": Vehicle to everything technology connects all types of vehicles and infrastructure systems with another. It includes other cars, infrastructure like highways, and other means of transportation, like public transport or ships and planes.

Source: Autocaat, 2016.

Figure 6: Communication, source Autocaat 2016

This communication is visualised in the picture below:

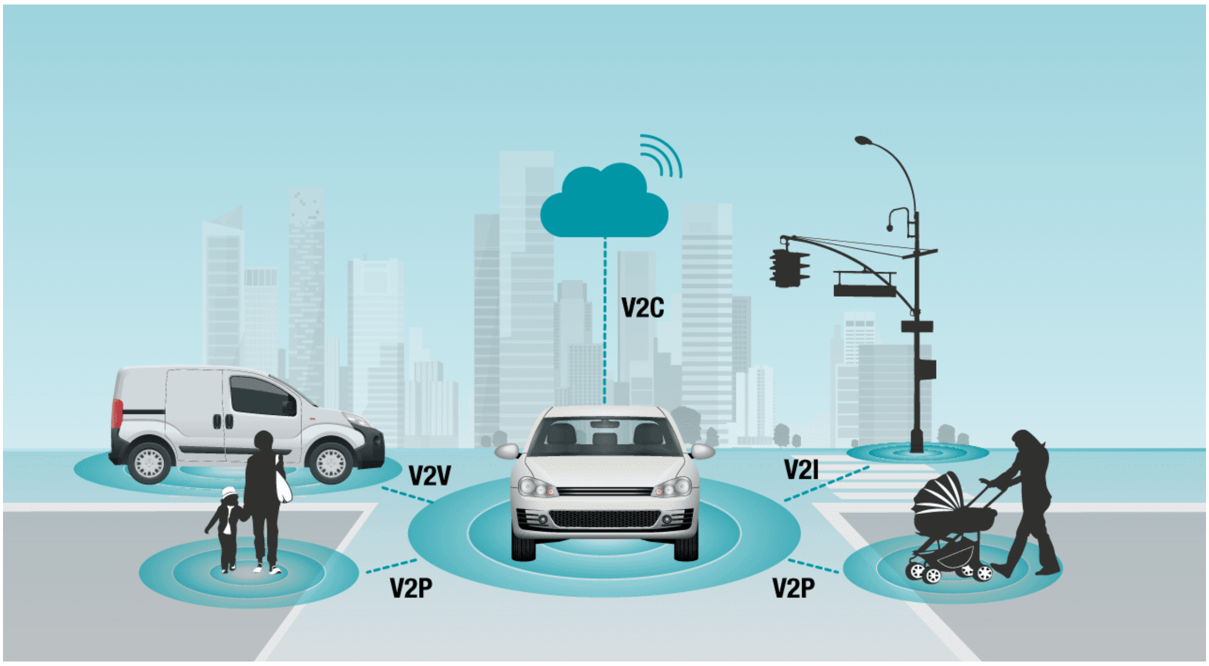


Figure 7, Communication types between a connected car and its environment, source Autocaat, 2016

Systems and services

A connected car is equipped with communication devices that enable its connectivity (IEEE, 2020). These devices connect the car with internal and external devices like networks that offer applications and services. These applications and services offer a large variety of functionality to the driver that ranges from safety features and infotainment solutions to efficiency solutions like parking- and roadside assistance and navigation by offering global positioning systems (GPS).

GPS

GPS is short for global positioning system (Techterms, n.d.). The system is used to discover the location of an object by using satellite navigation. The GPS technology already dates back from the 60s when it was first used by the US military. Nowadays GPS offers many commercial products for cars, mobile phones and geographical information systems (GIS).

The GPS system consist of 24 satellites that are deployed in space. The 24 satellites broadcast their position, orbit and time. By a process called triangulation, a GPS receiver is able to combine the broadcasts from multiple satellites to calculate its exact position.

ADASS

Advanced driver assistance systems (ADAS) gives drivers support. The ADAS system provides help to drivers in road traffic situations. ADAS can potentially contribute to a reduction of the crash involvement of drivers by offering the following functionality (European commission, ADAS, 2020):

Functionality	ADAS
Draws attention to approaching traffic	•Collision warning systems aimed at intersections •Automated lane changing and merging systems
Signals road users located in the driver's blind spot	•Automated lane changing and merging systems •Blind spot and obstacle detection systems
Assists the driver in directing his attention to relevant information	•In-vehicle signing systems •Special intelligent cruise control
Provides prior knowledge on the next traffic situation	•Systems that give information on the characteristics of complex intersections the driver is about to cross
	Source: European commission, ADAS, 2020

Table 5, ADAS functionality, source European Commission, 2020

C-ITS, cooperative intelligent transport systems

Cooperative intelligent transport systems (C-ITS) communicates between vehicles, the roadside infrastructure and other road users. These C-ICTS systems work by the use of wireless technologies (TCA, n.d.). In order to provide efficiency in transport networks and to improve diver's safety, C-ITS offers several services based on information and communication technologies (Researchgate, 2018). C-ITS systems are closely linked to connected vehicles.

4.2 Connected car and personal data

By explaining the connected car in the previous chapter, it becomes apparent that 'data' plays a key role in a connected car. Several types of data, including personal data, generated by different data sources in- or around the connected car flow in- and out of external clouds, databases, platforms and third-party networks. This may arise questions on topics like data security and perhaps equally as important, data privacy. The generated data from the connected car may be of interest for several parties. For instance automakers, insurers, the government (law enforcement) and other third parties. Personal data in relation to a connected car is about the individuals in the car, the driver and his or her passengers. This personal data consist for instance of information on driving behaviour, location, communication and infotainment systems data.

Since this data mentioned is linked to an individual it is, in accordance with European Union data protection legislation, labelled as personal data (European Union, 2019). Since it becomes clear that personal data is generated by a connected car, several potential data protection issues or challenges may arise when using connected cars:

Transparency

Connected cars generate data that may attract the interest of several third parties. Therefor it seems important that users of connected cars are informed about this in a transparent and informative way. They should be able to know who is using their personal data, to what purpose and for how long. To do so, data controllers, data processors and recipients should be identified. Without informing users of connected cars on the use of personal data, the consent to use the data should not be given.

Data collection

By applying more and more sensors in connected cars, it becomes possible that the amount of collected data exceeds the actual needs for the provided services to the user of the car. This so called excessive data collection can lead to the risk of using the excessive data for secondary purposes. Therefor the data minimisation principle can be enforced as required by the general data protection regulation (GDPR) (GDPR, n.d.).

Data retention

Data that is generated and- or exchanged by connected cars, should not be retained longer than necessary. The generated data should be stored and kept only to support the actual needs for the provided services to the user of the car. To prevent an indefinite storage of connected car data, a data retention policy could be provided to the connected car user.

Control

Connected car users should be able to control their personal data. Instead, data processing in a connected car can be triggered automatically or by default by the car. Connected car users should be made aware of this and enabled to control this personal data. The generation of personal data should be by consent of the driver and- or passengers only. They favourably must be offered means to manage- or turn the generation and distribution of personal data on- or off, and, if applicable and desirable, delete this data or the build-up of a so called activity history.

Purpose limitation

Data that is generated by connected cars and was mentioned for one purpose, could potentially be used for another purpose, which the users of the connected car are not aware of. For instance maintenance data from the car, could be used by insurance companies who could draw up driving behaviour from the driver and adjust personal insurance premiums accordingly. Or authorities could use the data to monitor speed limit violations. The purpose of the use of particular kinds of data should be limited to its use and the user of the car should be made clearly and transparently aware of that if this situation is otherwise.

Collection of sensitive data

According to Forbes car manufacturers need to take protection of sensitive data seriously. Privacy rules by the government need to be applied. (Forbes, 2019). Data that is generated by connected cars, about the use of the car, like destination, route, communication and infotainment, can contain sensitive and personal information about a person. Driving routines and places of interest can, besides being identified, reveal a person’s religion, political preference, sexual orientation or relationships. This information can become useful when matched with information out of existing databases, both private and governmental.

Before collecting this data, controllers should inform connected car users about the means and purpose of the use of location data. Requirements and rules on processing these kinds of sensitive data are available at the general data protection regulation. Data protection rules, protection principles on location data, purpose limitation and data storage regulations all should apply.

Security and access control

Confidentiality, integrity, and the availability of data, should be part of data security (KPMG, 2016). According to the 2017 European Union report ‘Access to In-vehicle Data and Resources’ in-vehicle data can be made accessible by either an on-board application platform, an in-vehicle interface or a data server platform (European Commission, 2017). Like all ICT environments, connected cars can also be vulnerable to security risks. The security risks exist of; cyber-attacks, unauthorised access and loss and misuse of data. These risks are possible even higher amongst rental cars, shared cars, taxi services and leased vehicles. The more different drives and passengers use connected cars, the more data is collected, so higher the risks and vulnerabilities become. This situation may call for a set of regulatory guidelines and tools in order to protect personal data. Next the connected car’s software should be updated on a regular basis against software patches that protect users against newly found security threats or vulnerabilities.

At an international conference on data protection and privacy in September of 2017 a resolution was drafted on data protection for automated and connected vehicles (IDPPC, 2008).

In its 2017 resolution the ICDPPC called upon all parties involved to respect user rights for the safeguarding of their personal data. The ICDPPC expressed its concern on the possible lack of information, data control, user choice and consent for users of connected and automated cars. Therefor the involved parties are urged to respect the privacy of- and safeguard personal data collected form connected. A brief summarization of the imposed measures by the ICDPPC is as follows:

1. Provide information on what data is collected, processed and the purpose of it;
2. Use methods to anonymize personal data;
3. Keep personal data no longer than necessary;
4. Provide means to erase data when a connected car is sold;
5. Provide privacy controls;
6. Provide technical means to restrict data collection;
7. Provide secure data storage;
8. Provide technical means for secure online communication;
9. Develop technology that:
    - prevents unauthorized access to personal data;
    - provides safeguard against tracking and tracing;
10. Respect the principles of privacy;
11. Develop privacy preserving technology for personal data;
12. Guarantee that self-learning algorithms are transparent in functionality and tested by an independent party;
13. Provide privacy-friendly driving modes settings;
14. Perform assessments on data protection for new implementations;
15. Process personal data responsible;
16. Enter a dialogue with privacy commissioners in order to develop compliance tools to provide legal certainty to connected vehicles related processing.

4.3 Connected car and data & legislation

The general data protection regulation (GDPR) is a law by the European Union that protects data and privacy within the European Union. The general data protection law (2016) comes in place of the data protection directive as the primary law that regulates how corporations protect personal data form EU citizens. The purpose of the general data protection law is to provide the member states of the EU with a uniform law on data security (Data insider, 2020).

The GDPR contains 99 articles, divided over 11 chapters. The 13 articles that are about data security, are listed in the table below:

Articles 17 and 18	Regulates the "right to portability" and the "right to erasure". It gives persons more control (to move and erase data) over their data;
Articles 23 and 30	Directs corporations to protect the private data of consumers against loss and or exposure;
Articles 31 & 32	Requires companies to report on data breaches, Article 32 requires data controllers to notify individuals asap on breaches when the breaches place their rights and freedoms at risk;
Articles 33 and 33a	Directs companies to perform data protection impact assessments on a regular basis;
Article 35	Demands from large corporations to appoint a data protection officer;
Articles 36 and 37	These articles describe the data protection officers position and its responsibilities;
Article 45	Demands data protection requirements to international companies that hold personal data of EU citizens. In this way the same rules apply as for native European companies;
Article 79	Describes the penalties for non-compliance to the GDR.

Source: European Commission, EU data protection rules, 2018.

Table 6,: GDPR articles, source European Commission, 2018

The general data protection law applies to each member of the European Union. The aim is create uniform protection of personal data within the EU. Privacy and data protection requirements of the GDP include:

- "Requiring the consent of subjects for data processing;
- Anonymizing collected data to protect privacy;
- Providing data breach notifications;
- Safely handling the transfer of data across borders;
- Requiring certain companies to appoint a data protection officer to oversee GDPR compliance;
- EU data protection rules" (European Commission, EU data protection rules, 2018).

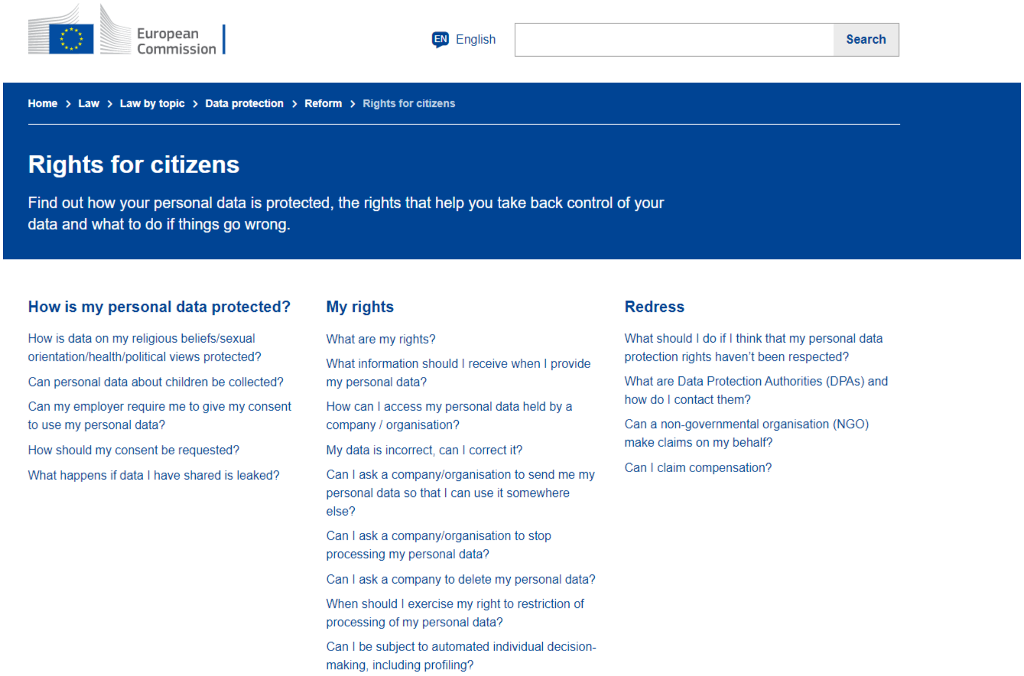


Figure 8: EU citizens' rights regarding data-protection, source European Commission, 2018

The French data protection authority (CNIL) encourages innovation and ensures data protection of personal data from car users (CNIL, 2017). CNIL created a connected vehicle compliance package. The package was created in close cooperation with the automobile sector, insurance and telecoms companies and public authorities. The package is offering a framework or a toolkit on the use of personal data. It is especially made for the handling of personal data that is collected from vehicle sensors, telematics and mobile applications. Personal data is referred to as all data associated to a natural person via the vehicle serial number. CNIL composed the following set of principles towards data protection of personal data:

KEY PRINCIPLES TO BE RESPECTED WITH REGARD TO THE FRENCH DATA PROTECTION ACT AND THE GENERAL DATA PROTECTION REGULATION

The processing of personal data shall comply with the French Data Protection Act. Any person wishing to process personal data is subject to a number of legal obligations.

THE PRINCIPLE OF INFORMATIONAL SELF-DETERMINATION

(article 1 of the French Data Protection Act) Article 1 of the French Data Protection Act provides that information technology shall be at the service of every citizen, and it shall not harm human identity, human rights, privacy, individual freedoms, or public liberties. In addition, pursuant to article 1, section 2, any person has the right to determine the use made of their personal data. That right to informational self-determination expresses the individual's necessary control over their data during the entire processing period.

THE OBLIGATION TO HAVE A LEGAL BASIS FOR THE PROCESSING IMPLEMENTED

(article 7 of the French Data Protection Act, and article 6 of the General Data Protection Regulation) Processing of personal data shall have received the consent of the data subject, or shall satisfy one of the following conditions: 1 - compliance with a legal obligation that is incumbent upon the data controller; 2 - protection of the data subject's life; 3 - carrying out a public-service mission entrusted to the data controller or the data recipient;

THE OBLIGATION THAT DATA BE PROCESSED FAIRLY AND LAWFULLY

(article 6-1° of the French Data Protection Act, and article 5-1° a/ of the General Data Protection Regulation) All processing of personal data shall be done under conditions that ensure transparency with regard to the data subjects, and it shall not be implemented without the knowledge of the data subjects. As a minimum, that obligation involves providing information to data subjects in accordance with article 32 of the French Data Protection Act, and, in some cases, obtaining their consent.

THE OBLIGATION THAT DATA BE OBTAINED FOR SPECIFIED, EXPLICIT AND LEGITIMATE PURPOSES

(article 6-2° of the French Data Protection Act, and article 5-1° b/ of the General Data Protection Regulation) Personal data can only be collected and processed for a specific, explicit, and legitimate use. Therefore, the objectives pursued by the data controller shall be defined beforehand in a clear, explicit, and exhaustive manner. Any use of personal data for an objective that is incompatible with the primary purpose of processing is a misuse that is subject to administrative or criminal sanctions.

THE LIMITED DATA RETENTION

(article 6-5° of the French Data Protection Act, and article 5-1° e/ of the General Data Protection Regulation) Personal data cannot be stored indefinitely in a file. The data controller shall determine a specific retention period based on the purpose of each processing operation. For example, a data controller cannot retain, for an unlimited period, the technical details of vehicles (identified in particular by means of the serial number) for the purpose of product improvement, unless the data are anonymized. However, legislative or regulatory provisions may require a data controller to retain data beyond the period during which they are stored in an active database. In that case, data can be stored in an archive database for the period required to comply with the obligation in question, in compliance with the conditions specified by the CNIL's discussion on the conditions of electronic archiving (cf. discussion no. 2005-213 of 11 October 2005); in such a case, reference is made to intermediate archiving.

THE OBLIGATION OF DATA SECURITY

(article 34 of the French Data Protection Act, and article 5-1° f/ of the General Data Protection Regulation) The data controller is bound by a security obligation

Picture source: CNIL, 2017.

Figure 9: Key principles CNIL, source CNIL,2017

4.4 Connected car and the ICT infrastructure

An ICT Infrastructure is needed as a basis for deploying intelligent transport systems (ITS) (European Commission, Intelligent transport systems, 2020). Systems that monitor road situations depend on consistent, relevant and high quality data. In Europe such an infrastructure is needed to enable services to traffic that crosses borders. This so called connected infrastructure is composed of three elements: collecting- and communication systems and protocols (European Commission, Intelligent transport systems, 2020).

Road operators use sensors, cameras and induction loops to collect data. This data is send to traffic control centres, where it is processed and forwarded to the old (radio, television) and new media (internet, apps). Nowadays this data is enriched by adding so called floating car data (FCD) and cell phone data. The data sources record date, time and location and complement the existing data. Location information is also provided by Satellite navigation. The European navigation satellite system is called Galileo. Galileo provides accurate global positioning services.

Since the communication of data has to be reliable, the DATEX information exchange protocol was introduced in Europe, and as so, supported by the European Union. DATEX has become the standard for communication and data exchange between traffic control centres in Europe. DATEX enables network management across borders.

Core systems that support the ICT infrastructure for (connected) cars include data collection systems, satellite navigation systems, traffic monitoring systems (both mobile and stationary), traffic control centres, communication protocols and data exchange systems.

The road authorities in the Netherlands, Austria and Germany initiated a project called Cooperative ITS Corridor. This corridor enables cooperative ITS services in Europe. The project focusses on:

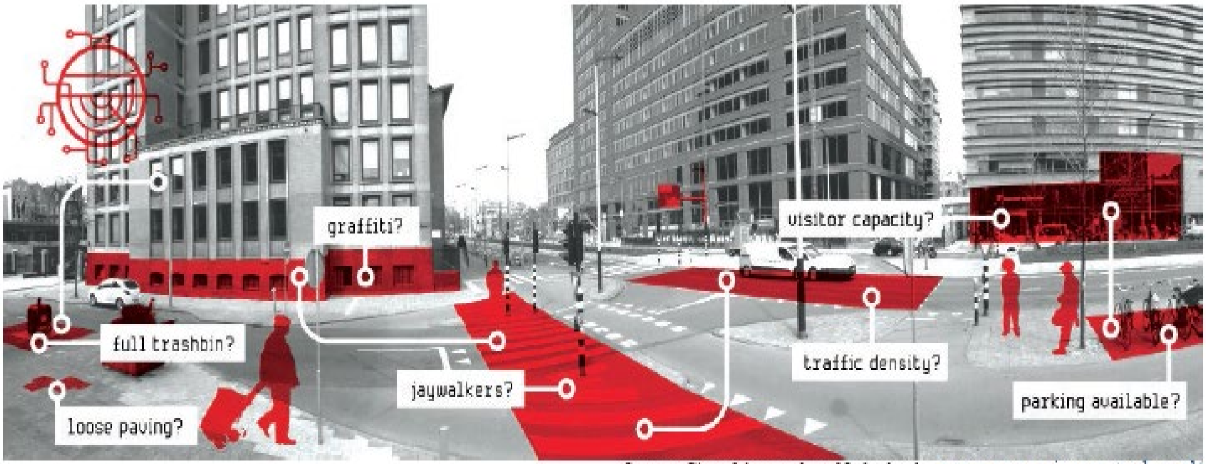
- Probe vehicle data;
- Collision risk warning.

The cooperative ITS Corridor is further elaborated on in chapter 4.8 of this thesis.

As stated earlier, an ICT Infrastructure is needed as a basis for deploying intelligent transport systems. The concept of smart cities can provide such an infrastructure for connected cars by using a collective network called the internet of things (IoT). The internet of things is constructed of a range of devices and apps that offer services to connected cars. It allows cities to create solutions for traffic congestion or environmental purposes. The internet of things connects infrastructure and human beings in real time mode (Vermesan et al., 2009). The internet of things can be explained as devices that are interlinked and send their messages through the internet (IBM, 2008).

A smart city uses technology to solve city problems. By interconnecting devices and people, communication is setup (Harrison & Donnelly, 2011). By interconnecting integration is established that will provide vital intelligence or information (Harrison & Donnelly, 2011). Intelligence, based on analytics is offered for decision-making (Harrison & Donnelly, 2011).

A different definition on smart city, was given by Gartner(Fenn, 2011) where a goal of the smart city is described; efficiency and sustainability. In A smart city information is exchanged between different systems in an intelligent way. The information flow that comes from this is exchanged with city inhabitants and corporations (Harrison & Donnelly, 2011).



Source: City of Amsterdam, Netherlands - www.measuringamsterdam.nl/

Figure 10, citizen input on aspects of the city's infrastructure, environment and services, source Measuring Amsterdam, n.d.

Within a smart city, connected cars communicate with advanced traffic management systems to create an efficient way of travelling, both in terms of traffic flow and in fuel or energy economy. The connected car gathers and shares information on roads, pedestrians, other vehicles and for instance traffic congestion. Smart cities can use this shared information to improve traffic flow and optimize public transport. Smart cities combine traditional networks and services with new networks and technologies, provided by for instance connected cars or cellular phones, so that, amongst others, traffic can benefit (European Commission, smart cities, 2018). By using information technology, a smart city is able to optimize transportation, emission and its resources.

4.5 Connected car and technical solutions to manage & control data

Nowadays the EU distinguishes technical solutions for two different environments: private cars and commercial vehicles.

Private cars	
European electronic toll service EETS.	Several countries within the European Union each have their own system for tolls. This variety in systems results in costs and administration for users. To avoid those, the European Union introduced a single electronic system for the payment of tolls: the European electronic toll service (EETS). The EETS legislation is effective since 2014 and supporting hardware will become available in the near future.
eCall.	eCall is an initiative by the European Union to give assistance to motorists in the EU, who are involved in a collision. The eCal system automatically dials the emergency number in the event of a road accident. The vehicle's location is automatically communicated to the emergency services. eCall is mandatory for all new cars sold in the EU since 2018.
Commercials vehicles	
Digital Tachograph Obligatory for Commercial Vehicles.	The digital tachograph is a fitted to a commercial vehicle. It digitally records the vehicles speed and distance, together with the driver's activity.
European electronic toll service EETS.	Legislation is effective since 2012 and technical solutions will become available in 2020 for Commercial Vehicles.
eCall.	eCall devices is mandatory in all newly produced commercial vehicles in the EU since the end of 2014.
Dangerous goods- and livestock tracking.	Further directives and regulations are being prepared by the EU for the tracking of transportation of dangerous goods and livestock.
	Source: CECRA, n.d.

Table 7: two environments, source CECRA, n.d.

Several parties related to the automobile industry, like for example the ICDPPC and CERCA, urge governments for the development of technical solutions to manage, control and safeguard (personal-) data from connected cars.

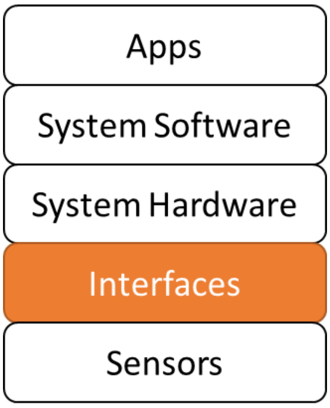
Together with input from CECRA the EU currently establishes an open telematics platform with ready to use standardised and secure data. The open telematics platform should provide connected car users with a technical possibility to control data sharing with third parties. CECRA is the European organisation for car manufacturers and dealerships (CECRA, n.d.). Although CECRA's motivation for such an open telematics platform might be commercially intended, the cooperation between the automotive industry and the government on this topic, could potentially push the development of an open telematics platform forward.

To push the connected car technology further, many concerned parties plead for a secure framework, both technical and legal, on a national or even global level. According to them the Vienna Convention of 1968 dictates chauffeurs should be able to manage their car in all situations. This could potentially also apply to the personal data the vehicle generates (VDA, 2015).

Basically four technical architectures for data exchange for connected cars exist nowadays (RAP Trans, 2010):

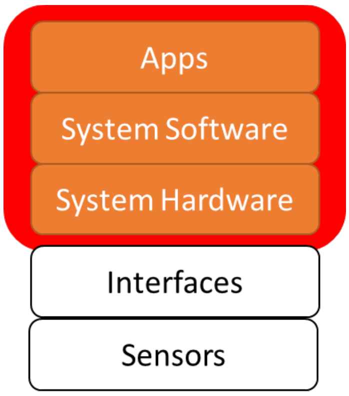
The generic on-board services

- The generic on board services concept is based on the universal on-board unit (UOBU) that collects sensor data from the vehicle;
- The interface provides on board applications with a set of data collected from sensors.



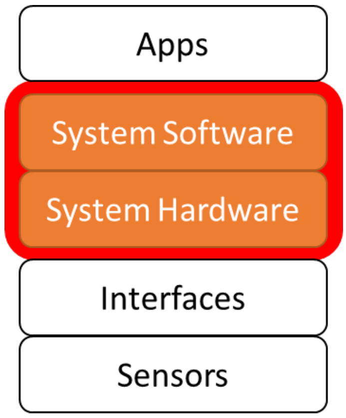
A standardised box

- Applications are embedded in one device;
- The device combines sensors, modules and functions in order to fulfil the governmental regulations;
- The digital tachograph in commercial vehicles could for example be used as a basic architecture to build the box on;
- Data exchange is transparent through a predefined interface, like bluetooth.



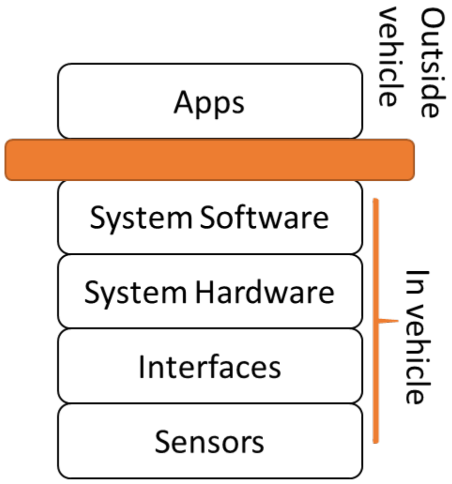
A common platform

- An operating system runs on top of an existing architecture. Devices like a cellular phone or an embedded system could be the basic architecture;
- Variables like time and position are shared through application programming interfaces (API's);
- Multiple developers can contribute to this platform by the availability of a software development Kit;
- Security, reliability and privacy issues have to be addressed.



The off-board approach

- In vehicle equipment collects and forwards data;
- External service providers process data;
- The certification of service providers by independent authorities is advised;



This off board approach was adopted in the development of a technical solution by working group six. As a representative for public and private stakeholders, group six supports building techniques to handle data from connected cars (European Commission, 2017). Next to technical solutions, working group 6 also provides principles to handle data from connected cars. The working group wants to achieve an open platform.

Three technical solutions for the access to in-vehicle data and resources were proposed:

- “A data server platform;
- An in-vehicle Interface;
- An on-board application platform (European Commission, 2017).

The three solutions work together to:

- “Send data from the data server platform to a back-end server;
- Data and the application using that data are now placed outside the vehicle;
- Access to the data is given by using an In vehicle interface inside the vehicle;
- The on-board application platform allow access and control over the data and the execution of applications inside the vehicle” (European Commission, 2017).

The user or owner of the vehicle can now decide if and what kind of data can or will be provided and to whom. This also includes the purpose for the use of the data.

4.6 The Ministry of Infrastructure & Water Management

The Ministry of Infrastructure and Water Management wants to protect the environment, enhance the quality of life in Holland and support its mobility. Therefor an infrastructure network of roads and waterways is maintained (Government, n.d.).

The research for this study is commissioned at the Ministry of infrastructure and water management, its agency Rijkswaterstaat and in particular the department of traffic management. All parties mentioned are considered as stakeholders. In the organogram below, the ministry and its agencies are displayed.

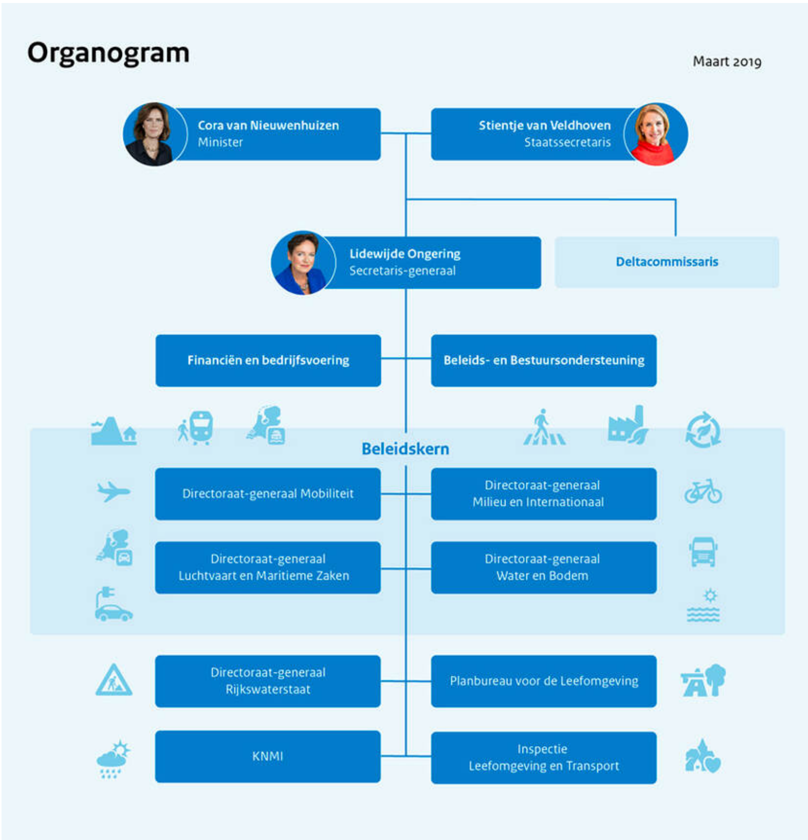


Figure 11, Organogram of ministry I&W, source Government, n.d.

Policy on data

Rijkswaterstaat formulated a policy on data that consists of two basic rules:

- "All Personal data are handled in accordance to the law: the personal data protection act;
- Personal details are only processed if the user has been notified" (Rijkswaterstaat, Privacy statement, n.d.).

4.7 Rijkswaterstaat as an agency of the ministry

Rijkswaterstaat is a substitute of the Ministry of Infrastructure and Water Management and promotes safety, mobility and the quality of life in Holland (Rijkswaterstaat, Our organization, n.d.). Since 1798 Rijkswaterstaat manages roads and waterways in the Netherlands. Throughout the years the organisation and the tasks that Rijkswaterstaat performs have changed. The major changes are displayed in the 'stepping stones' figure below:

Year 1795 "the bureau voor den waterstaat" was originated under the French rule to manage roads and waterways;

Year 1848 the name of the organisation was changed to Rijkswaterstaat;

Year 1920 the way Rijkswaterstaat worked was influenced since the twenties by a number of technical advances, like new measuring techniques and reinforced concrete, enabling Rijkswaterstaat to work in a different and technological more advanced way;

Year 1930 due to a worldwide economic crisis, massive programs were created by the government to provide work and to counter rising unemployment levels. Infrastructure projects like "the Afsluitdijk" were established by Rijkswaterstaat;

Year 1940 the Second World War broke out in Holland. Many infrastructure was destroyed and had to be rebuilt after the war;

Year 1953 a great flood destroyed parts of the south west of the Netherlands. To prevent this from happening again, the delta works were initiated and constructed;

Year 1960 owning a car becomes available to people. The number of cars on the Dutch roads rise and so do incidents and environmental pollution. Rijkswaterstaat has to improve road safety and come up with ways to protect the environment against polluting;

Year 1970 the role of Rijkswaterstaat starts to change. Rijkswaterstaat becomes more and more a team player and transforms "from maker to manager". Nowadays citizens and interest groups are involved in the decision making.

Year 2013 Rijkswaterstaat was reorganised into a more lean and efficient organization. It nowadays consist of "a board, a Directory General, 10 regional services, 36 districts and 5 national services" (Binnenlandsbestuur, 2008).

Source: Rijkswaterstaat, our-history, n.d.

Figure 12: History Rijkswaterstaat, source: Rijkswaterstaat, n.d.

The mission of Rijkswaterstaat

Rijkswaterstaat describes its mission on their public web side. It is as follows: "*Rijkswaterstaat manages and develops highways and waterways, and provides a sustainable living environment. Together we work on a country that is protected against floods. Where there is an abundance of nature and abundant clean water. Where you can move swiftly and safe from A to B. Working together on a safe, liveable and reachable Holland, that is Rijkswaterstaat*" (Rijkswaterstaat, our-organisation, n.d.).

The strategy of Rijkswaterstaat

Rijkswaterstaat also describes its corporate strategy on their public web side. In the document 'Koers 2020' Rijkswaterstaat explains what it is aiming to achieve with its strategy (Rijkswaterstaat, Koers 2020, n.d.): "*Society is getting more complex and many different actors (government, citizens, media, and local communities) interact in an increasingly dynamic way. Through the birth of social media a participative democracy rises that affects the way choices are made*".

According to its strategy Rijkswaterstaat has to become:

- "**Agile**: the networking society asks for a flexible and agile government;
- **Connected**: with citizens, communities, corporations, and the world of knowledge, politics and government. Cooperation is a must, to operate solo is no longer an option and or accepted;
- **Open**: development to an open and more transparent Rijkswaterstaat, for instance open data. Another type of workers: different and higher demands to our workers: hip and flexible people, modern networkers and people who know more of less (return of the nerd)" (Rijkswaterstaat, Koers 2020, n.d).

The table below summarises Rijkswaterstaat' way to achieve its transformational goals:

"Goal	Steps to achieve goal
a Sustainable environment	• Create and manage energy neutral objects (bridges, slushes, tunnels); • All company vehicles will become electric.
Smart mobility: collaboration, experiment and invest	Develop in cooperation with the ministry a vision on the public role; • work on smarter mobility by 'doing by learning'; • work together with partners on providing better traffic information; • embrace the ambitions of connecting mobility, the program that will speed up the transition to smart mobility.
Bring cohesion in meaning, rules and values	• do not lose yourselves in rules and regulations; • work on the meaning behind the rules; • keep and pass on knowledge and experience and work in a uniform way as one organisation.
Steer on values, a different way of working. **More room to take responsibility and ownership**	Work together on core values: • result driven; • approachable; • service minded; • honourable; • enterprising; • connecting.
Standpoints of our work, where do we want to be in 2020?	• work as one and use experiences of customers to improve; • clear tasks and responsibilities; • people know what's expected and are highly motivated; • work from trust and responsibility with room for talent; • keep improving; • leaders serve and leave work to the workers, they focus on support".
	Source: Rijkswaterstaat, Koers 2020, n.d

Table 8: Koers 2020, source Rijkswaterstaat, n.d.

The i-Vision and i-Strategy of Rijkswaterstaat

For the information technology domain of Rijkswaterstaat a separate vision and strategy are developed. These so called i–vision and i-strategy support the organisational goals as described earlier in this chapter by the mission and strategy statements of Rijkswaterstaat. The i-vision and i-strategy were developed "with a focus on standardization and unification" (IT-academie overhead, 2018).

Rijkswaterstaat describes their i-vision and i-strategy as follows:

“The i-vision shows future options on how information provisioning can contribute to the Rijkswaterstaat organisation. The i-vision provides direction and is not considered an end-state. Concrete and desired steps that are developed, will become part of the i-strategy. The i-vision will grow in maturity and will show how Rijkswaterstaat can adjust its services to a constantly changing society. The i-vision is meant to create awareness and direction” (Rijkswaterstaat, werkwijze, n.d.).

With the i-strategy a transformation will be accomplished from information provider into a broker for the government in Holland. This will be accomplished by having a strong network infrastructure. The data that Rijkswaterstaat gathers and stores will become more and more important for Rijkswaterstaat and its alliances. In the future, shared information positions will be developed were data can be exchanged (Rijkswaterstaat, werkwijze, n.d.).

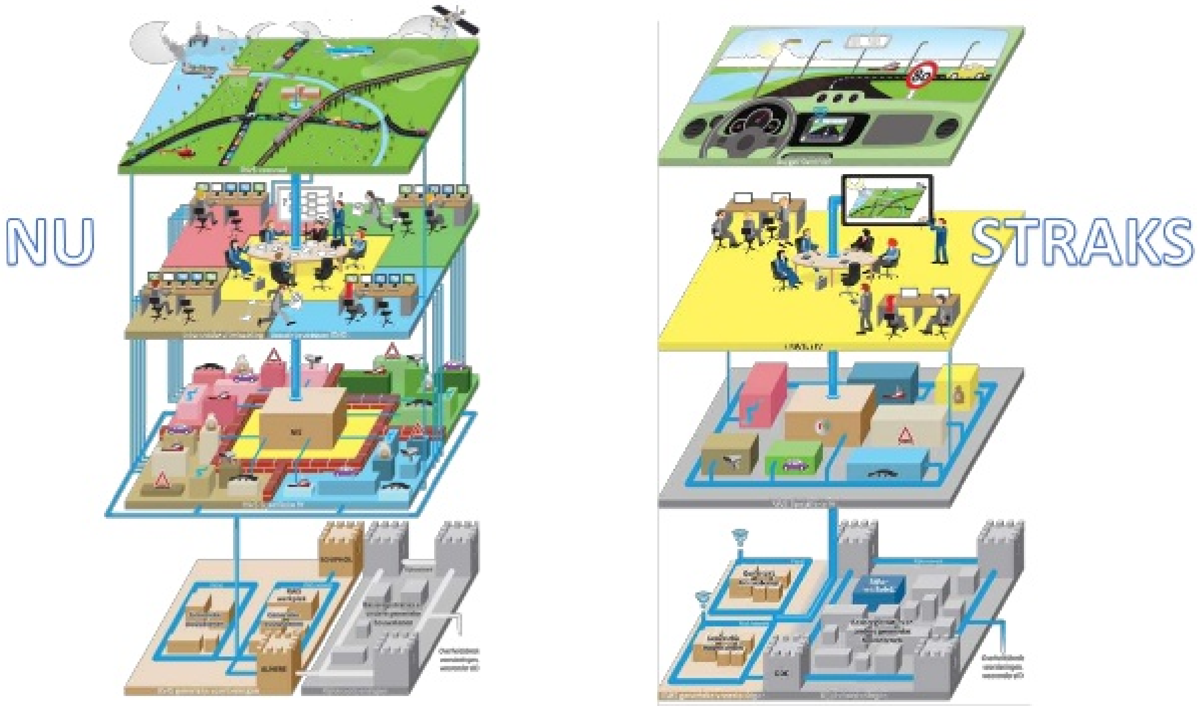


Figure 13: Transformation of Rijkswaterstaat, source Rijkswaterstaat, werkwijze, n.d.

4.8 Rijkswaterstaat traffic management and data

The Dutch government works on a future proof and sustainable mobility with less carbon dioxide pollution. The challenge is to combine fast, safe and comfortable mobility with sustainability.

The current Dutch parliament wants to reduce the carbon dioxide emission in the Netherlands by 49% compared to the year 1990 (Rijkswaterstaat, Duurzame mobiliteit, n.d.). In order to achieve these goals and also be able to guarantee fast, safe and comfortable mobility, the current mobility system in the Netherlands needs to change.

Rijkswaterstaat therefor stimulates the use of; bikes, electrification, sustainable fuel for cars and trucks, the construction of sustainable road infrastructures and the development of smart systems that facilitate different ways of travel (Government.nl, n.d.). This infrastructure needed therefor includes the topics as displayed in the figure below:

"Highways;

The Dutch mobility policy serves 2 goals: Reliable journey times and better accessibility. The Dutch economy relies heavily on transport and logistics, the main economic centres must remain accessible;

Waterways;

Dry feet, sufficient clean water and reliable and useful information is what integrated water management means to Rijkswaterstaat. Smooth and safe transport by water are other ways of using water;

Water systems;

They include (1) Integrated water management; achieving the most efficient and flexible construction, management and maintenance of the main water systems in the Netherlands. (2) Dry feet; The Dutch coast protects Holland from the sea. That is why it is important to maintain it properly. (3) Sufficient clean water; Clean and healthy water is a matter of life and death for people, animals and nature. (4) Protection against water; a large part of The Netherlands lies below sea level; that makes it vulnerable to flooding".

Source: Rijkswaterstaat, our-organisation, n.d.

Figure 14, Infrastructure, source Rijkswaterstaat, n.d.

Traffic and transportation modelling

Transportation of people and goods in the Netherlands is of importance to the Dutch government. In order to get people to their workplace in time and goods to its destination, an infrastructure is essential (Rijkswaterstaat, Verkeers- en vervoersmodellen*,* n.d.). The infrastructure of the Netherlands needs constant maintenance and extension in order to accommodate this. To guide and plan the extension of the infrastructure Rijkswaterstaat uses strategic traffic and transport models; LMS (National Model System) and NRM (Dutch Regional System). Data generated by connected cars or car users, could potentially be used to improve the planning and guidance of maintenance and extension of the infrastructure.

LMS and NRM are applied in different ways. The systems are used to investigate alternative options for infrastructure projects, or to determine the effects of governmental policies on the infrastructure. To gain insight into the benefits or disadvantages of construction of new infrastructure or expansion of existing infrastructure, Rijkswaterstaat needs to know how many vehicles drive on what highway. In this way alternatives can be provided in terms of travel times, noise reduction and emissions. Furthermore the calculated prognoses can be used for reports on the environmental effects of certain choices and cost- profit analyses.

Big data

Transport models, like the origin – destination matrix (OD-Matrix) gives insight on travel movements. The matrix tells Rijkswaterstaat on what time, in which way and with what reason people move. The matrix helps Rijkswaterstaat to create traffic prognoses and supports decision making on expanding the infrastructure in the Netherlands. Rijkswaterstaat continuously improves the way data is gathered, since this effects the impact on traffic prognoses in a positive way. Since 2017 smartphone data of motorists is added to the OD-matrix.

Smart mobility

In order to keep the Netherlands reachable, safe and liveable, Rijkswaterstaat uses new information and communication technology. The use of innovative ICT solutions is called smart mobility (Rijkswaterstaat, Smart Mobility, n.d.). Road users benefit from smart mobility, for example by receiving accurate information on traffic congestion, the availability of parking spaces or road works. Smart mobility also contributes to sustainable forms of transportation. Smart information systems can inform travellers on efficient and sustainable ways of transportation. By using smart technology, vehicles can travel more efficient and therefor consume less fuel.

A growing number of vehicles nowadays have an on board GPS (global positioning system) receiver (Rijkswaterstaat, Smart Mobility, 2017). Also, drivers make use of navigation applications on their smartphones while driving. Via a communication network, it becomes possible to track the GPS data of the drivers, either from the GPS receiver in the car or the use of the smartphone application. This so called floating car data is automatically transferred to a service provider. The service provider on his turn then sends this data to a traffic information centre of Rijkswaterstaat. The received GPS data provides information on the time and location of a vehicle. This offers Rijkswaterstaat to the opportunity to calculate the most efficient travel routes / times, set temporary speed limits in order to guarantee optimal flow of traffic, and protect road users for collisions in case of traffic jams by informing incoming traffic ahead.

Probe vehicle data

Rijkswaterstaat is testing the use probe vehicle data from moving cars in order to maintain infrastructure, increase road safety and support mobility in an innovative way. Probe Vehicle Data uses both mobile and fixed beacons along the highways. These beacons gather sensor data via Wi-Fi-P

(Wireless Fidelity added with WAVE - wireless access in vehicular environments -) from passing vehicles. This anonymized sensor data, like speed, position and lights status is used for traffic management purposes. Probe vehicle data differs from floating car data since different sources and communication is used; Wi-Fi-P is used instead of 3G or 4G, sensor data is retrieved instead of GPS and cell phone data (Rijkswaterstaat, Smart Mobility, 2017).

ITS corridor

Together with Germany and Austria, Rijkswaterstaat works on the realisation of a number of intelligent transport systems (ITS) by executing the project cooperative ITS corridor (Computable, 2018). Cooperative ITS services connect vehicles and the road infrastructure in order to create safe and efficient traffic systems. This implementation contributes to European developments on smart mobility. Road works warnings, actual road condition information and collision risk warnings contribute to safety, less accidents, more effective road use, lower emissions and a better information support to road users.

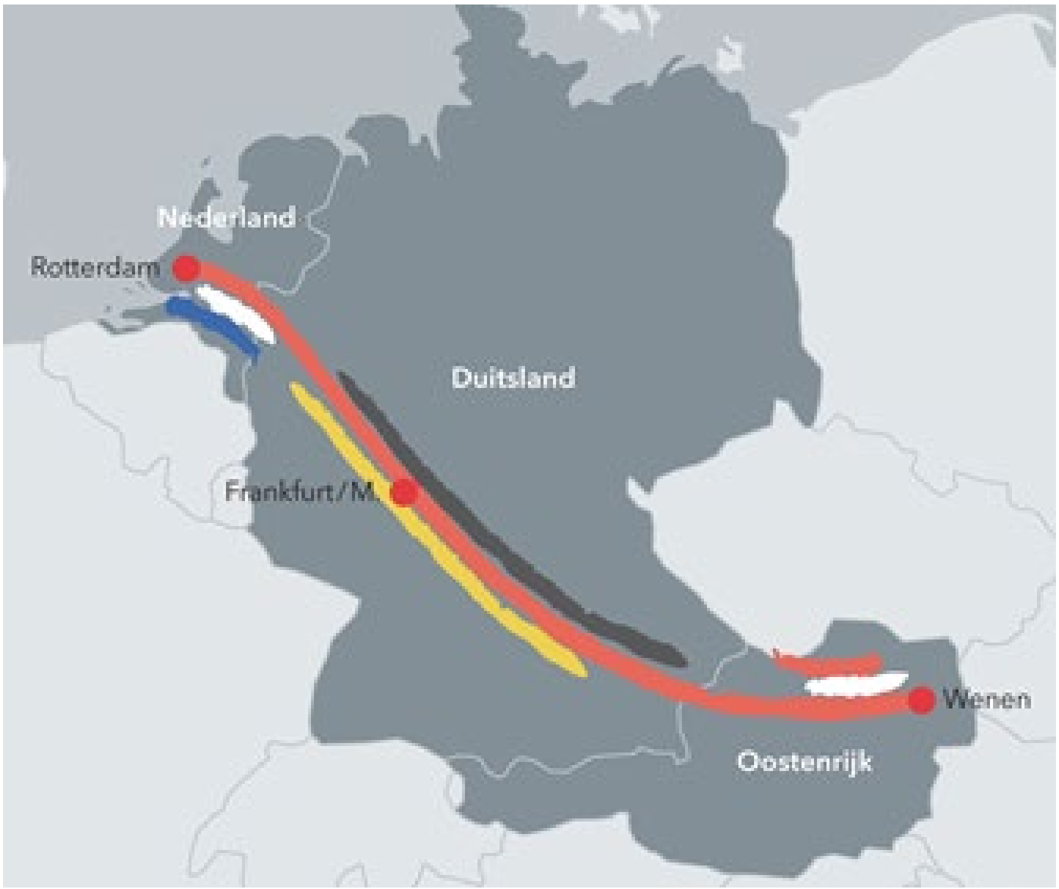


Figure 15, displaying the ITS corridor, source Computable, 2018

CHARM

CHARM will replace the thirty currently used different traffic management systems. The CHARM program helps Rijkswaterstaat to shape the future of traffic management (Rijkswaterstaat, Charm programma, n.d.).

CHARM is a smart ICT platform for the use within traffic centres and mobile solutions that will offer:

- Flexibility: a basis for innovative traffic management;
- Scalability: capability to support the ever growth of road infrastructure and users;
- Cost efficiency: reduction of maintenance and management cost.

The CHARM program consist of a number of lots (Rijkswaterstaat, Charm programma, n.d.):

Lot 1

- Advanced network management, self-learning decision software that supports traffic controllers in order to increase mobility and lower emissions;
- Distributed network management, supports drivers via in car systems to move in an optimal way through traffic, this results in less travel time, avoidance of collisions and less emission.

Lot 2

- Prediction and detection of incidents, this offers actual and optimal information on expected traffic situations for traffic controllers. This system combines different data sources like floating car data, camera data, rain radar data, Twitter and various related apps. The system will lead to less dependency on the current detection systems, present in the road surface (which are less densely installed and thus offer lower data quality and are costly to maintain).

Lot 3

- In-car systems for autonomous traffic management, actual vehicle information gathered by data on the use of brakes, lights and windscreen wipers is communicated via Wi-Fi-P technology to other road users (V2V) and the road infrastructure (V2I);
- A Transportation System that combines a smartphone app with in car equipment to send vehicle data to a Rijkswaterstaat traffic centre in order to provide drivers with tailored traffic and location information.

5. Results

Introduction

In this chapter, the results of the pre-study, survey and literature and desk study are represented. After the completion of the data collection, the results were analysed. Only those results that are relevant were included.

The literature study

The connected car generates vast amounts of data. This generated data may contain private information. The data is used for many purposes that can offer convenience to its users. Third parties may also use the data and for various reasons. This can generate questions on security of the data and the privacy of its owner. Will people share their data and if so, what kind of data would they share? In case of the connected car, would they if possible, share only technical data, or would they agree to communicate for instance vehicle location and route information for their convenience? What triggers our behavior intension in these situations? One could state that the way we act is closely related to the theory of planned behavior. The awareness of being 'watched' could potentially influence ones behaviour, since it may affect our privacy.

The theory of planned behaviour suggests that human action is influenced by beliefs on behaviour, normative and control. Beliefs about the presence of factors that may facilitate performance of the human behavior. Control beliefs give rise to perceived behavioral control or the ability to produce a desired or intended result. If a positive attitude towards all three beliefs is present, the theory predicts a high probability for forming an intention that leads to a certain act.

The survey

An important part of my research consist of a survey. This survey is added as an annex to this document. The questions in the survey were carefully selected in order to get usable data. Prior to the creation of the survey, interviews with members of the Rijkswaterstaat staff were held, in order to gain inside and create relevance in the questions. Before executing the survey, a test-run amongst ten random co-workers was done. Based on the outcome of this test, the questions were further fine-tuned. The survey data then was collected among a population of individuals working for the Dutch government. The sample consists of employees from the Rijkswaterstaat department of traffic management. The targeted group consist of eighty people, females as well as males, between the age of 18 and 65. The group received the survey by email and were requested to cooperate; to fill out the survey and return it by email. Those who didn't respond, received a reminder after a week of the initial request. The survey is written in Dutch, since Dutch is the main language used at the ministry and all participants speak Dutch. Of the eighty targeted employees, 56 responded. Those 56 responses were processed. For the statistical analyses of the retrieved data, the SPSS tool was used. The SPSS software offers advanced statistical analysis.

Analytical model

In order to the match the outcomes of the survey with the theory of planned behavior, the table below was constructed. The human action, steered by three kinds of beliefs from the theory are described in the left column and in the centre column the constructs, the outcome is displayed at the right column, whereas a red cross stands for negative association and a green smiley for a positive association with the particular belief.

Theory of planned behavior checklist (source: Ajzen, 1991)		Present Y/N
Behavioral attitudes	**Affective attitude**	
How a person thinks and feels about behaviour and reflects expectations and evaluations about behaviour	Is behaviour enjoyable or not	
	Instrumental attitude	
	Is behaviour beneficial or harmful	
Normative beliefs	**Injunctive norms**	
Relates to support given or not given by others	Refers to others that encourage the behaviour	
	Descriptive norms	
	Whether others do the behaviour as well	
Perceived behavioral control	Person **feels capable and confident** to execute behaviour	
	Perception that person has the **capabilities to overcome barriers and challenges**	

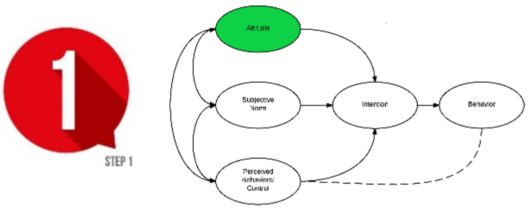
Table 9, checklist for beliefs

Results

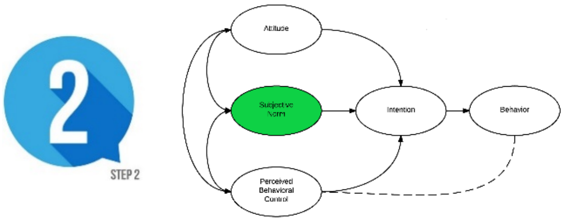
The research results are, per research question, systematically represented in compliance with the order of the model of the theory of planned behavior. After a start off with the general results from the frequency tables, at first the behavioral attitude results are presented, secondly the normative beliefs, thirdly the control beliefs and fourthly the results regarding the Intention that leads to behavior. Finally the results of the desk study will be presented.

General results

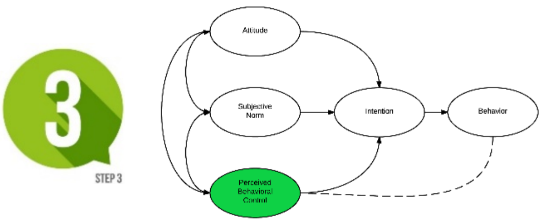
Behavioral believes - Attitude



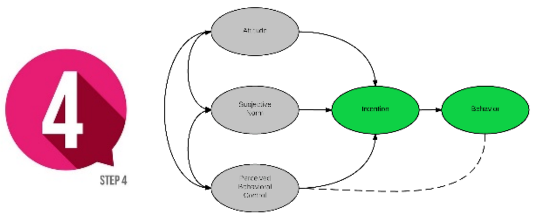
Normative beliefs - Subjective norm



Control beliefs / Perceived behavioral control



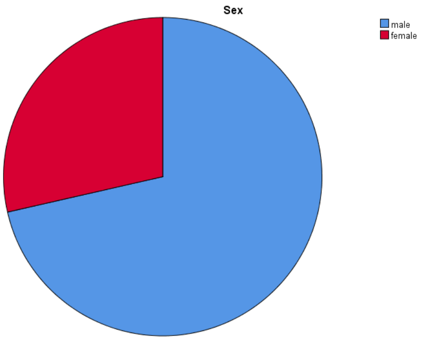
Behavioral intention



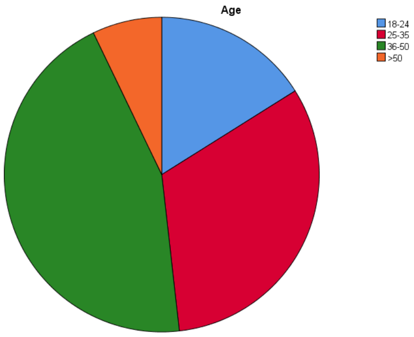
Desk study results

General results from the SPSS frequency tables

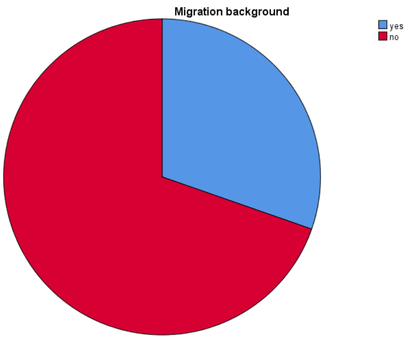
The frequency of a data value is the number of times the data value occurs. The frequency of the data value of the survey held, is represented by the frequency tables below. The tables are constructed by arranging collected data values in ascending order of magnitude with their corresponding frequencies:



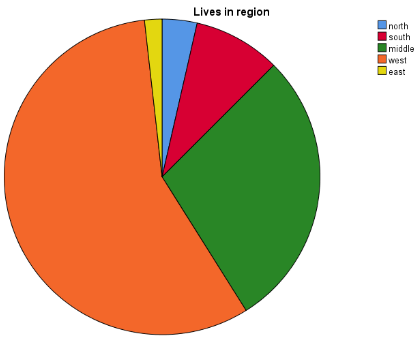
The majority of the participants of the survey were male 71,4%, against 28,6% female.



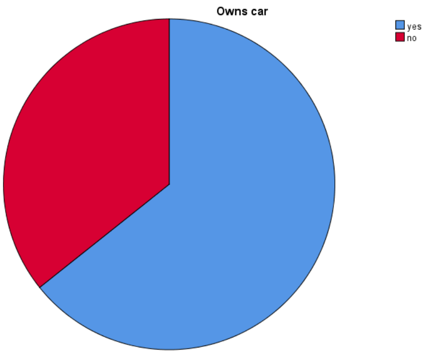
Most of the participants, 44,6%, belong to the age category 36-50 years old.



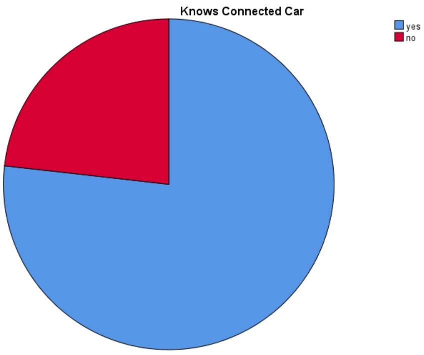
A minority of 30,4% of the participants has a migration background.



The majority of the participants live in region west, 57,1%.



The majority of the participants of the survey own a car 64,3%.



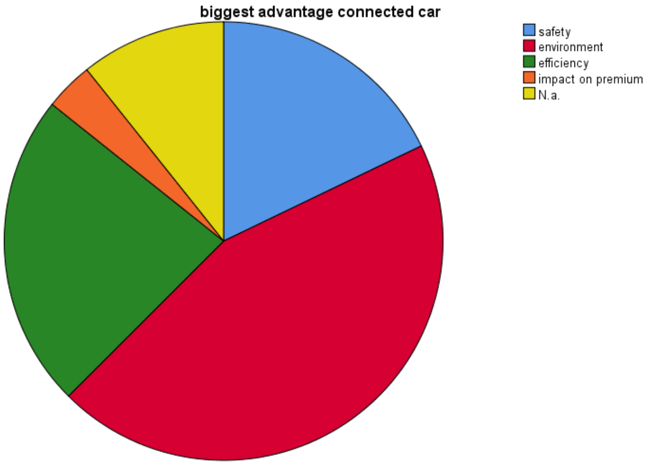
A minority of 23,2% of the participants has no understanding of the phenomena connected car.

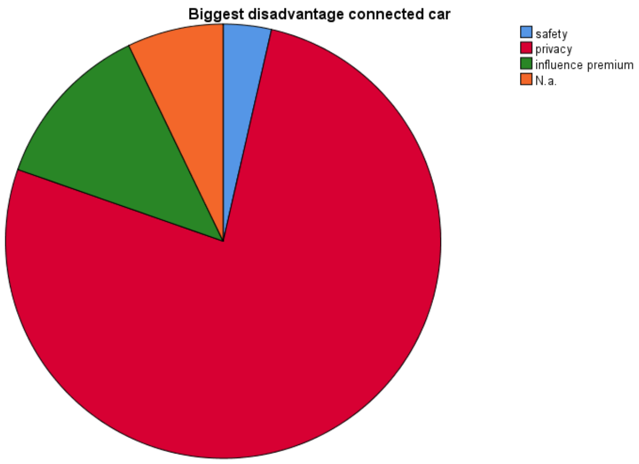
Results on behavioral believes - Attitude

In relation to the main research question

"To what extent can the theory of planned behavior explain behaviour intension towards connected car regarding privacy and data control?"

In the survey the participants were asked about what they think is the biggest advantage and disadvantage of a connected car. The majority of 76,8% of the participants feel that 'privacy' is the biggest disadvantage of a connected car. The (positive) impact on the environment is seen as the most positive aspect of a connected car, by 44,6% of the participants.





Participants were asked what they thought was the impact of the connected car technology on a variety of options. The majority of 83,9% thought that the most impact of the technology is: less privacy. 85,7% of the participants felt strong about the importance of less privacy.

Impact: less privacy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	47	83,9	83,9	83,9
	No	9	16,1	16,1	100,0
	Total	56	100,0	100,0	

Importance of less privacy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	48	85,7	85,7	85,7
	No	8	14,3	14,3	100,0
	Total	56	100,0	100,0	

Behavioral attitudes towards PRIVACY in relation to connected car (source: Ajzen, 1991)		**Present Y/N**
Behavioral attitudes How a person thinks and feels about behaviour and reflects expectations and evaluations about behaviour	**Affective attitude** Is behaviour enjoyable or not	
	Instrumental attitude Is behaviour beneficial or harmful	
Normative beliefs Relates to support given or not given by others	**Injunctive norms** Refers to others that encourage the behaviour	
	Descriptive norms Whether others do the behaviour as well	
Perceived behavioral control	Person **feels capable and confident** to execute behaviour	
	Perception that person has the **capabilities to overcome barriers and challenges**	

Results on normative beliefs - Subjective norm

In relation to the Main research question

Participants were asked if they thought that the society is concerned on the topic of 'privacy' in relation to the connected car. A majority of 75% of the participants show concerns:

Privacy concerns of society towards connected car

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Concerned	42	75,0	75,0	75,0
	Neutral	10	17,9	17,9	92,9
	Not concerned	4	7,1	7,1	100,0
	Total	56	100,0	100,0	

Participants were asked if they thought that other people would change their driving behaviour if they were monitored. 73,2% of the participants thought other people would change their driving behaviour if monitored:

Change driving behaviour if monitored

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	41	73,2	73,2	73,2
	No	13	23,2	23,2	96,4
	N.a.	2	3,6	3,6	100,0
	Total	56	100,0	100,0	

A performed Chi-Square test supports this outcome:

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3,233[a]	4	,520
Likelihood Ratio	3,901	4	,420
Linear-by-Linear Association	,037	1	,847
N of Valid Cases	56		

a. 6 cells (66,7%) have expected count less than 5. The minimum expected count is ,14.

Participants were asked if they thought that other people would avoid certain locations if they knew that they were monitored. 75% of the participants thought that other people would avoid locations if they knew they were monitored:

Avoid locations if monitored

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	42	75,0	75,0	75,0
	No	8	14,3	14,3	89,3
	N.a.	6	10,7	10,7	100,0
	Total	56	100,0	100,0	

Normative beliefs towards LOCATION and PRIVACY in relation to connected car (source: Ajzen, 1991)		**Present Y/N**
Behavioral attitudes How a person thinks and feels about behaviour and reflects expectations and evaluations about behaviour	**Affective attitude** Is behaviour enjoyable or not **Instrumental attitude** Is behaviour beneficial or harmful	
Normative beliefs Relates to support given or not given by others	**Injunctive norms** Refers to others that encourage the behaviour **Descriptive norms** Whether others do the behaviour as well	 
Perceived behavioral control	Person **feels capable and confident** to execute behaviour Perception that person has the **capabilities to overcome barriers and challenges**	

In relation to the sub research question:

"What are the normative beliefs when driving a connective car?"

Results from the literature study:

A connected car generates data and from that privacy concerns may arise. These privacy concerns may affect ones normative beliefs. Data that is generated by connected cars about the use of the car, like destination, route, communication and infotainment, can contain sensitive and personal information about a person. Driving routines and places of interest can, besides being identified, reveal a person's religion, political preference, sexual orientation or relationships. This information can become useful to third parties for various reasons, when matched with information out of existing databases, both private and governmental.

Results from the survey:

Participants were asked if they thought that other people would change their driving behaviour if they were monitored. 73,2% of the participants thought other people would change their driving behaviour if monitored:

Change driving behaviour if monitored

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	41	73,2	73,2	73,2
	No	13	23,2	23,2	96,4
	N.a.	2	3,6	3,6	100,0
	Total	56	100,0	100,0	

Participants were asked if they thought that other people would avoid certain locations if they knew that they were monitored. 75% of the participants thought that other people would avoid locations if they knew they were monitored:

Avoid locations if monitored

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	42	75,0	75,0	75,0
	No	8	14,3	14,3	89,3
	N.a.	6	10,7	10,7	100,0
	Total	56	100,0	100,0	

Theory of planned behavior checklist (source: Ajzen, 1991)		Present Y/N
Behavioral attitudes	**Affective attitude**	
How a person thinks and feels about behaviour and reflects expectations and evaluations about behaviour	Is behaviour enjoyable or not	
	Instrumental attitude	
	Is behaviour beneficial or harmful	
Normative beliefs	**Injunctive norms**	✗
Relates to support given or not given by others	Refers to others that encourage the behaviour	
	Descriptive norms	✗
	Whether others do the behaviour as well	
Perceived behavioral control	Person **feels capable and confident** to execute behaviour	
	Perception that person has the **capabilities to overcome barriers and challenges**	

In relation to the Sub research question:

"Will the availability of 'privacy protective legislation' on data gathered and distributed from a connected car influence normative beliefs towards connected car?"

Results from the literature study:

My literature research for this thesis study reveal that a considerable amount of important privacy protective legislation is already in place. The general data protection regulation (GDPR) for instance is a regulation in EU law on data protection and privacy in the European Union. The French data protection authority (CNIL) encourages innovation and ensures data protection of personal data from car users. CNIL created a connected vehicle compliance package to make this possible (CNIL, 2017).

Results from the survey:

From the survey, participants were asked in question number 7 if people would avoid certain locations if they knew that anyone else could see that location, 75% of them thought so:

avoid locations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	42	75,0	75,0	75,0
	No	8	14,3	14,3	89,3
	Don't know	6	10,7	10,7	100,0
	Total	56	100,0	100,0	

Participants were asked if they were willing to share their data, if this data is protected by law. 91,1% of the participants of the survey were willing to share their data if it was protected by law:

Willing to share data if data is protected by law (p1)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	51	91,1	91,1	91,1
	No	4	7,1	7,1	98,2
	N.a.	1	1,8	1,8	100,0
	Total	56	100,0	100,0	

A crosstab test was performed to see if there is a relation between the outcomes of these two survey questions. This is a method to quantitatively analyse the relationship between variables. It is used to find patterns or probabilities within a data set:

Share data if protected by law * avoid locations cross tabulation

			avoid locations		
			ja	nee	weet niet
Share data if protected by law	Yes	Count	38	8	5
		Expected Count	38,3	7,3	5,5
	No	Count	3	0	1
		Expected Count	3,0	,6	,4
	Don’t know	Count	1	0	0
		Expected Count	,8	,1	,1
Total		Count	42	8	6
		Expected Count	42,0	8,0	6,0

Share data if protected by law * avoid locations cross tabulation

			Total
Share data if protected by law	Yes	Count	51
		Expected Count	51,0
	No	Count	4
		Expected Count	4,0
	Don’t know	Count	1
		Expected Count	1,0
Total		Count	56
		Expected Count	56,0

From the crosstab test it becomes evident that the population from the questionnaire is willing to share their data if they were protected by law while doing so, this has a positive effect on the control beliefs. Whilst without this protection the same population think people would avoid locations in regards to privacy concerns; this effects the normative believes in a negative way.

Theory of planned behavior checklist (source: Ajzen, 1991)		Present Y/N
Behavioral attitudes How a person thinks and feels about behaviour and reflects expectations and evaluations about behaviour	**Affective attitude** Is behaviour enjoyable or not	
	Instrumental attitude Is behaviour beneficial or harmful	
Normative beliefs Relates to support given or not given by others	**Injunctive norms** Refers to others that encourage the behaviour	
	Descriptive norms Whether others do the behaviour as well	
Perceived behavioral control	Person **feels capable and confident** to execute behaviour	
	Perception that person has the **capabilities to overcome barriers and challenges**	

Results on control beliefs - Perceived behavioral control

In relation to the main research question

Participants were asked if they desired influence over the distribution of their location- and speed data. 78,6% of the participants wanted influence on the transmission of location data and 80,4% over their speed data:

Wants influence on transmitting location data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	44	78,6	78,6	78,6
	No	11	19,6	19,6	98,2
	N.a.	1	1,8	1,8	100,0
	Total	56	100,0	100,0	

Wants influence on transmitting speed data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	45	80,4	80,4	80,4
	No	10	17,9	17,9	98,2
	N.a.	1	1,8	1,8	100,0
	Total	56	100,0	100,0	

Participants were asked if they desired influence over the receiving party of their speed- and location data. 71,4% of the participants wanted influence on the receiving party of speed data and 69,6% wanted influence over the receiving party of their location data:

Wants influence on receiving party of speed data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	40	71,4	71,4	71,4
	No	15	26,8	26,8	98,2
	N.a.	1	1,8	1,8	100,0
	Total	56	100,0	100,0	

Wants influence on receiving party of location data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	39	69,6	69,6	69,6
	No	16	28,6	28,6	98,2
	N.a.	1	1,8	1,8	100,0
	Total	56	100,0	100,0	

Participants were asked if they want to have or own connected car technology themselves, 64,3% acknowledged the desire to have the technology:

Wants to have connected car technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	36	64,3	64,3	64,3
	Maybe	6	10,7	10,7	75,0
	No	11	19,6	19,6	94,6
	Don't know	3	5,4	5,4	100,0
	Total	56	100,0	100,0	

Participants were asked if they are willing to pay for connected car technology, 60,7% of the participants seem willing to pay for it:

Willing to pay for connected car technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	34	60,7	60,7	60,7
	Maybe	9	16,1	16,1	76,8
	No	11	19,6	19,6	96,4
	Don't know	2	3,6	3,6	100,0
	Total	56	100,0	100,0	

Control beliefs towards connected car (source: Ajzen, 1991)		**Present Y/N**
Behavioral attitudes How a person thinks and feels about behaviour and reflects expectations and evaluations about behaviour	**Affective attitude** Is behaviour enjoyable or not **Instrumental attitude** Is behaviour beneficial or harmful	
Normative beliefs Relates to support given or not given by others	**Injunctive norms** Refers to others that encourage the behaviour **Descriptive norms** Whether others do the behaviour as well	
Perceived behavioral control	Person **feels capable and confident** to execute behaviour	
	Perception that person has the **capabilities to overcome barriers and challenges**	

In relation to the sub research question:

"Can the availability of a technical solution to manage and control data gathered and distributed from a connected car, like an 'open telematics platform' influence control beliefs on connected car?"

Results from the literature study:

It is believed that an open in-vehicle platform architecture would allow to address barriers like legal and privacy aspects, harmonisation and lack of standards and specifications regarding connected vehicle data. Already a number of standardized and mandatory technical requirements for cars and commercial vehicles are available in the European Union. With the rapid development and deployment of connected car technology, the urge for a technical solution possible grows (Rapp Trans, 2010).

Results from the survey:

In the survey the participants were asked in question 12 about the biggest disadvantage of connected car technology. The frequency table below shows that the majority of the participants, 76,8%, feel that 'privacy' is the biggest disadvantage of a connected car:

Biggest disadvantage connected car

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sequrity	2	3,6	3,6	3,6
	Privacy	43	76,8	76,8	80,4
	Influence premium	7	12,5	12,5	92,9
	N.A.	4	7,1	7,1	100,0
	Total	56	100,0	100,0	

To check if participants were reluctant to share their personal data, they were asked in question 8 if they desired control over the transmitting of their personal location- and speed data. As the frequency table below displays, a large majority of the participants acknowledged the need for having control over transmission of their speed-(80,4%) and location data (78,6%):

Influence sending location data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	44	78,6	78,6	78,6
	No	11	19,6	19,6	98,2
	Don'tknow	1	1,8	1,8	100,0
	Total	56	100,0	100,0	

Influence sending speed data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	45	80,4	80,4	80,4
	No	10	17,9	17,9	98,2
	Don't know	1	1,8	1,8	100,0
	Total	56	100,0	100,0	

From the survey, participants were asked in question number 10 if they were willing to share more data, if they had some sort of control over sending and receiving it. In this experiment the hypothesis is that having a technical solution that enables people to manage and control data gathered and distributed from a connected car, influences control beliefs equally over the population.

H0= evenly divided over the population
H1= unevenly divided over the population

A Chi square test was performed to test the situation. This Chi square test, tests if within the variable values defer from the expected value.

Share data if control

	Observed N	Expected N	Residual
Yes	49	18,7	30,3
No	3	18,7	-15,7
Don't know	4	18,7	-14,7
Total	56		

Test Statistics

	Share data id control
Chi-Square	73,964[a]
df	2
Asymp. Sig.	,000

a. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 18,7.

The test statistics show that the alpha value is less than 5%. There is no significance found on the even distribution. From the test it becomes obvious that people who are given control over managing and controlling their own data, as retrieved from a connected car, are more willing to share their data.

Theory of planned behavior checklist (source: Ajzen, 1991)		**Present Y/N**
Behavioral attitudes How a person thinks and feels about behaviour and reflects expectations and evaluations about behaviour	**Affective attitude** Is behaviour enjoyable or not **Instrumental attitude** Is behaviour beneficial or harmful	
Normative beliefs Relates to support given or not given by others	**Injunctive norms** Refers to others that encourage the behaviour **Descriptive norms** Whether others do the behaviour as well	
Perceived behavioral control	Person **feels capable and confident** to execute behaviour	
	Perception that person has the **capabilities to overcome barriers and challenges**	

Behavioral intention; recapitulation of results

Significance

The theory of planned behavior suggests that behavior is based on beliefs. Human intentions capture motivational factors that influence behavior. These intentions are formed from three factors: “attitude toward the behavior, subjective norms and perceived behavioral control” (Ajzen, 1991). The attitude towards behavior is about an individual's positive or negative perceptions of performing the behavior. Subjective norms reflects the human impression of other's feelings about performing the behavior, they are essentially peer pressure. Finally perceived behavioral control. It captures the human perception of their capability to perform the behavior. It is based on past experience, anticipated issues and skills, abilities and opportunity. The theory of planned behavior predicts a high probability for forming a behavioral intention that leads to displayed behavior or act if a positive attitude towards all three beliefs is present.

The following hypotheses arise, whereas the relation between the three beliefs and intention is tested:

- H1: Personal attitude has a positive influence on intention
- H2: Subjective norms have a positive influence on intention
- H3: Perceived control has a positive influence on intention

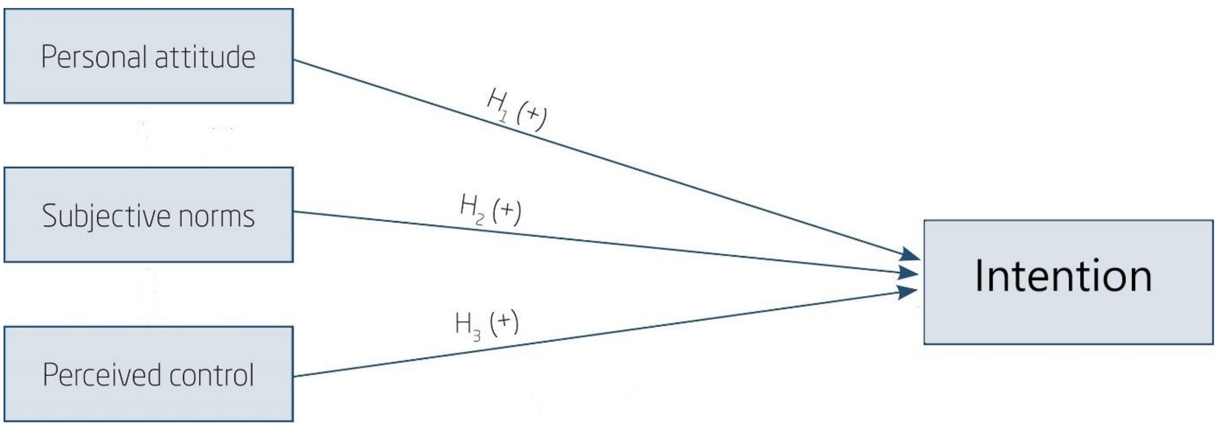


Figure 16 Hypothesis beliefs towards intention

H1. According to the outcome of the survey ‘personal attitude’ has a negative influence on intention, presenting a majority of individuals (83,9%) that thought that the most impact of connected car technology is less privacy. Whereas 85,7% of the participants felt strong about the importance of privacy. This outcome does not support H1.

H2. Based on the outcome of the survey, a positive relationship between subjective norms and Intention was not supported. The chi square test resulted in a 66,7% expected count of alpha less than 5, rejecting hypothesis H2.

H3. From the chi square test it becomes obvious that people who are given control over managing and controlling their own data are more willing to share their data, providing evidence to support H3.

Hypotheses	Observed value
H1: Personal attitude has a positive influence on intention	Not supported
H2: Subjective norms have a positive influence on intention	Not supported
H3: Perceived control has a positive influence on intention	Supported

In case of this study the outcome of the survey as presented in the previous chapter's shows a negative response towards behavioral beliefs, a negative response towards the normative beliefs and a positive response towards the control beliefs. This means that the probability of forming a favourable behavioral intention towards connected car is low.

Desk study results

In relation to the sub research question

"Will the current capability level of connected car technology allow Rijkswaterstaat to use retrieved data from connected cars to further safeguard, manage and control traffic on Dutch highways?"

My desk study on the Rijkswaterstaat organisation gives insight into the organisational design of Rijkswaterstaat and its mission, the strategy and organizational goals. It reveals an organisational transformation over time (Rijkswaterstaat, our-organisation, n.d.). Today, Rijkswaterstaat involves more and more users of roads and waterways in its planning and decision making and works together on innovation topics with commercial parties. The concept of the connected car fits well within the new way of working of Rijkswaterstaat for the following reasons:

From the document 'Koers 2020' we learn that Rijkswaterstaat wants to work energy neutral in order to protect the environment. Also all company vehicles will become electric ones. The connected car is in many ways environmental friendly, for instance by being efficient in fuel economy by choosing the optimal route to a certain destination. The connected car also allows Rijkswaterstaat to retrieve information on traffic in a different, more efficient and sustainable way. Instead of gathering traffic information by loops in the asphalt, the connected car offers information by communicating with its environment as displayed in the image below:

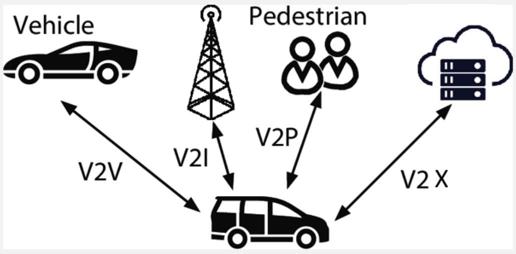
V2I "Vehicle to Infrastructure": devices such as sensors collect data generated by the vehicle and provides this information to the infrastructure and, on its turn, infrastructure information is provided back to the connected car. The V2I communicates about safety, mobility and environmental (infrastructure) related conditions;

V2V "Vehicle to Vehicle": Information about speed and position of surrounding vehicles is communicated to the connected car through a wireless information exchange. The goal of V2V communication is to avoid accidents and dissolve traffic congestions;

V2C "Vehicle to Cloud": vehicle to loud enables data exchange of information between the connected car and a cloud system. This enables the connected car to use information from other sources or services like services, maintenance, transportation and smart devices and vice versa;

V2P "Vehicle to Pedestrian": by the use of sensors, information about the connected cars environment is communicated to the driver and to other connected vehicles. Also surrounding infrastructure as well as personal mobile devices can be connected. This enables the connected car to communicate with its surroundings, such as pedestrians and thereby improve road safety and mobility;

V2X "Vehicle to Everything": Vehicle to everything technology connects all types of vehicles and infrastructure systems with another. It includes other cars, infrastructure like highways, and other means of transportation, like public transport or ships and planes.



Source: Autocaat, 2016.

Figure 17: Communication, source Autocaat, 2016

Smart mobility is one of the innovation pillars of Rijkswaterstaat in the information and communication technology domain. The connected car is all about smart mobility. According to the i-strategy Rijkswaterstaat transforms from information provider into a broker for the government in Holland (Rijkswaterstaat, Informatievoorziening, n.d.). Rijkswaterstaat retrieves, generates, stores and distributes vast amounts of data. So also from a strategic data perspective, the connected car and its data become ever more important to Rijkswaterstaat.

The connected car delivers several types of data from different sources:

Figure 18, types of data, source KPMG, 2017

Rijkswaterstaat is capturing data from these sources, mostly by V2I "Vehicle to Infrastructure" communication. From the available data sources, two types of data are actually used by Rijkswaterstaat:

- Floating car data (FCD)
- Probe vehicle data

Probe vehicle data finds its source in vehicle sensor data, which is transmitted via Wi-Fi-P. Floating car data finds its source in a GPS receiver or a smartphone, and is transmitted by satellite (for GPS) and over 3G or 4G (smartphone).

From the available data sources of the connected car, Rijkswaterstaat uses:

- GPS units
- On-board sensors
- External devices, including smart phones & wearables
- Telematics and telemetry

Several projects and proof of concepts are executed by Rijkswaterstaat to test the use of floating car data and probe vehicle data:

- Big data (The origin – Destination matrix)
- Smart mobility
- Probe vehicle data
- ITS corridor
- CHARM

The data quality and the usability for Rijkswaterstaat of the floating car data and probe vehicle data from connected cars has been subject of my research and the following findings are noted:

Probe vehicle data

Rijkswaterstaat uses anonymised probe vehicle (sensor) data to benefit traffic management (source: interview Yvonne Dierikx, information analyst, traffic management, Rijkswaterstaat, January 8th 2020). This data is transmitted by ETSI ITS standards (European telecommunications standards institute) and send via a secure Wi-Fi-P connection. International security and privacy legislation is respected by Rijkswaterstaat. Along the route Rotterdam (via Breda, Tilburg, Eindhoven) Venlo, Rijkswaterstaat placed beacons that communicate with passing connected vehicles. The retrieved data is stored in a central database.

Pros of probe vehicle data:

- Probe vehicle data is a relative cheap way of gathering traffic information;
- The solution is very flexible since most of the beacons are portable and don't require to be mounted in the road surface;
- This way of data retrieval, harvests more data than traditional methods, since there is no longer a dependency on physical loops in the road service;
- The retrieved data is of high quality.

Cons of probe vehicle data:

The availability of connected cars that transmit probe vehicle data is still limited;

- The amounts of retrieved data is vast, retrieving and analysing these volumes of data require investments in new techniques capable of handling huge volumes of data;
- Privacy and security concerns arise and need to be addressed;
- The accuracy of the positioning of probe vehicle data is low.

ICTS corridor and floating car data

Next to probe vehicle data, Rijkswaterstaat uses floating car data to benefit traffic management (source: interview Marcel Ririassa, project manager, dept. traffic management, Rijkswaterstaat, January 13th 2020). Within the ITS corridor, at the highway A58 location Roosendaal, Rijkswaterstaat is testing floating car data. The results are promising: speed, congestion, start and finish of traffic jams are all well detectable with the use of floating car data.

Pros of floating car data:

- Floating car data is a relative cheap way of gathering traffic information;
- The availability of floating car data is high (compared to probe vehicle data);
- The solution is very flexible since most of the beacons are portable and don't require to be mounted in the road surface;
- This way of data retrieval harvests more data than traditional methods, since there is no longer a dependency on physical loops in the road service;
- The retrieved data is of high quality.

Cons of floating car data:

- The availability of connected cars that transmit probe vehicle data is still limited;
- The amounts of retrieved data is vast, retrieving and analysing these volumes of data require investments in new techniques capable of handling huge volumes of data;
- Privacy and security concerns arise and need to be addressed;
- The accuracy of the positioning of floating car data is low;
- There is a delay between sending and delivering floating car data. This so called latency results in a much lower credibility/usability of floating car data (in comparison to conventional methods or the use of probe vehicle data);
- There is a lack of quality criteria in Europe for data and services.

The use of floating car data in transport models like the origin – destination matrix (OD-Matrix)

The transport models that Rijkswaterstaat uses require a detailed description of travel behaviour. Floating car data could potentially be used to benefit the transport models. However, at present time, the suppliers of floating car data only provide speed data on road segments. In the near future floating car data is expected to provide improved knowledge of traffic situations and is already used to test and improve the allocation of car traffic (WCTR, 2019).

In 2017 Rijkswaterstaat tested the use of cell-phone data within the origin – destination matrix, with promising results. Cell phone data contributes to the quality of the data within the OD-Matrix (Rijkswaterstaat, verkeers- en vervoersmodellen, n.d.).

6. Conclusion

The digital technology is turning to developing connectivity between the car and the world that surrounds it. The connected car has the capability to bring optimization to its own operation and maintenance. These features provide support to the driver and passengers (Habeck et al., 2014). A connected car generates different types of data, generated by a variety of data sources which are distributed by different data flows. In a continuously-connected car the driver's behaviour could be monitored by third parties. Information can potentially become useful and even misused when matched with information out of existing databases. With the awareness of being watched, are people still willing to share connected car data? What triggers their behavior intension? One could state that that behavioral achievement depends on ones beliefs. The awareness of being 'watched' could potentially influence ones behaviour, since it may affect our privacy.

Behavioral intention towards connected car

"To what extent can the theory of planned behavior explain behaviour intension towards connected car regarding privacy and data control?"

In the near future, the automotive industry could be transforming. A connected car produces, receives and transmits huge data volumes. These volumes can reach up to 4 terabyte per day (Future of privacy forum, 2019). Next to the so called in car experience, improvements in driver safety, comfort and convenience is increasing by connectivity. This increased connectivity calls for new data security mechanisms to ensure the integrity of automotive systems, while protecting consumers from the risk of intentional cyberattack or theft or misuse of personal data. Security and privacy concerns can be related to a number of topics, such as: politics, regulation, economics, technology adoption and logistics. Data privacy and security can become an issue in connected car technology. If a car is constantly (internet-) connected, there is a possibility that the driver's behaviour could be monitored by third parties. The European Commission tries to protect drivers by providing protective legislation, but the EU also supports equal data access for data from connected cars. The question that rises is if people will share their data voluntarily if they have that option? What triggers people's behavior intension in these situations? One could state that that behavioral achievement depends on ones beliefs. The awareness of being 'watched' could potentially influence ones behaviour, since it may affect our privacy. Why do we do what we do or act the way we act? The theory of planned behaviour tries to explain this and is build out of a number of so called constructs.

The first construct is the Attitude towards an act or behaviour. It's about an individual's belief of a certain act that makes a positive or negative contribution to that person's life. The second construct is the Subjective norm. It focuses on everything around the individual, social network, group beliefs or cultural norms. The third construct is Perceived behavioral control. It's about a person's belief on how easy or hard it is to display certain behavior or act in a certain way.

Results from the survey

For this thesis, data was collected via a survey among a population of individuals working for the Dutch government. Of the eighty targeted employees, 56 responded. The majority of the participants of the survey were male and most of the participants belong to the age category 36-50 years old, living in the western part of the Netherlands. Most of them own a car and have an understanding of the concept connected car. Participants were asked fifteen multiple choice questions categorised into the three constructs of the theory of planned behaviour; behavioral beliefs, normative beliefs and control beliefs. The outcome of the survey is further specified in the sections below, but in general shows a negative response towards the behavioral beliefs in relation to the topic of privacy concerning connected car, a negative response to the normative beliefs concerning location and privacy in relation to connected car and a positive response to the control beliefs towards connected car. The mind-set of the participants isn't favourable towards a connected car in terms of a fear for privacy, they are reluctant to share data and desire control on data distribution. Once control over data is given, participants tend to be more willing to share data.

Privacy concerns regarding connected car

"What are the normative beliefs when driving a connective car?"

The theory of planned behavior predicts a high probability for forming a behavioral intention that leads to displayed behavior if a positive attitude towards all three beliefs is present. From the survey it shows a low probability to a positive outcome or a positive attitude, since the outcome of the survey shows a negative response towards two out of three beliefs in relation to the topic of 'privacy' concerning connected car. So it is fair to say that the displayed behavior of the majority of the participants of the survey has no positive attitude towards connected car in terms of privacy concerns. A connected car and its passengers generate data and from that data generation privacy concerns may arise. These privacy concerns may affect ones normative beliefs. To overcome, people should be informed in a transparent and informative way about possible privacy concerns. They should be able to know who is using their personal data, to what purpose and for how long. They should be aware of the risk of excessive data collection from using a connected car, which can lead to the risk of using the excessive data for secondary purposes. To assure users, data that is generated and- or exchanged by connected cars, should not be retained longer than necessary. Data that is generated by connected cars and was mentioned for one purpose, should not be used for another purpose, without consent. Data that is generated about the use of the car, like destination, route, communication and infotainment, can contain sensitive and personal information about a person. Driving routines and places of interest can, besides being identified, reveal a person's religion, political preference, sexual orientation or relationships. This information can become useful when matched with information out of existing databases, both private and governmental. It would make sense to protect connected car users from misuse.

Privacy legislation and protection of data

"Will the availability of 'Privacy Protective Legislation' on data gathered and distributed from a connected car influence normative beliefs towards connected car?"

The GDPR is a regulation in the European Union law. It is about data protection and privacy.

This law applies to each member of the European Union and aims to "create uniform protection of personal data within the EU". The GDPR states that "consent of subjects is required for data processing and it assures anonymization of collected data to protect privacy" (Data insider, 2020). EU member state France, even goes a step further and suggest a connected vehicle compliance package as designed by its data protection authority. One could suggest that by having these initiatives mentioned, there is a form of privacy protective legislation that protects owners of the data, gathered and distributed from a connected car.

From the survey, the population questioned show concerns regarding personal data distribution by avoiding certain locations if monitored. The cross tabulation shows that if their data is protected by law, the same population is willing to share its data. Whilst without this data protection by law, the same population would avoid locations in regards to privacy concerns. This shows that normative beliefs can be altered in a positive way, if the interest of the population is served, and in this case data generated by a connected car is protected by legislation.

Open telematics platform and control

"Can the availability of a technical solution to manage and control data gathered and distributed from a connected car, like an 'open telematics platform' influence control beliefs on connected car?"

Study results from this thesis show that governments are urged by the automobile industry and other interest groups for the development of technical solutions to manage, control and safeguard (personal-) data from connected cars. It is believed that an open in-vehicle platform architecture would allow to address issues like legal and privacy aspects, harmonisation and lack of standards and specifications regarding connected vehicle data. A technical solution can be provided by the four technical Architectures available nowadays; generic on-board services, a standardised box, a common platform or an off-board approach.

Currently the European Union distinguishes technical solutions for two different environments: private cars and commercial vehicles. Unfortunately those technical solutions the European Union distinguishes do not address the need to manage, control and safeguard (personal-) data from connected cars. Hope on a swift solution is provided by the C-ITS working group 6, as part of the European initiative from the C-ITS Platform. The working group proposes several technical solutions for the access to in-vehicle data and resources that allow the user or owner of a vehicle can to decide if and what kind of data can or will be provided and to whom.

A performed chi square test, underlines this need. It shows in the specific test case used for this study that people are pointing out privacy concerns as the biggest disadvantage of a connected car and desire influence on the transition of speed and location data from their connected car, whereas the same population is willing to share personal data, if protected by legislation. The test statistics show that the alpha value is less than 5%. There is no significance found on the even distribution. From the test it becomes obvious that people who are given control over managing and controlling their own data as retrieved from a connected car, are more willing to share their data.

Usability by Rijkswaterstaat

"Will the current capability level of connected car technology allow Rijkswaterstaat to use retrieved data from connected cars to further safeguard, manage and control traffic on Dutch highways?"

One could answer in a positive way to the research question: "Will the current capability level of connected car technology allow Rijkswaterstaat to use retrieved data from connected cars to further safeguard, manage and control traffic on Dutch highways?", but not without making some remarks;

The data that Rijkswaterstaat retrieves from connected cars is promising and contributes to traffic management and safety on Dutch Highways. It supports the goal of the Dutch parliament to reduce the carbon dioxide emission in the Netherlands, and it supports the strategic goals of Rijkswaterstaat as described in 'Koers 2020' and the 'i-Strategy', whereas smart mobility supports smarter mobility and better traffic management by 'doing by learning' and in close collaboration with partners. It supports the willingness to be more agile, open, connected and sustainable. However, from the interviews held, it becomes clear that the use of floating car data and probe vehicle data is still being tested in a number of projects and is not in operational use. From these projects it becomes clear that the benefits can be found in savings on costs, efficiency and higher data proceeds. Combined with existing (conventional) data, connected cars complement and enrich the data that is used to manage and safeguard traffic. There are still a number of obstacles to overcome; new techniques capable of handling huge volumes of data need to be put in place, privacy and security concerns need to be addressed; the accuracy on the positioning of connected car data needs to be improved, latency has to be resolved in floating car data and European quality criteria for data and services are needed for quality cross-border services when using data from different countries. Finally the number of connected cars on the roads has to increase over time and suppliers of floating car data need to expend on data provisioning with the enrichment of the retrieved data from connected cars with travel behaviour, to make the data even more useable.

Discussion and further research

The population selected for the survey and interviews used in this thesis study consist of workers form Rijkswaterstaat. One could argue that this targeted group is not fully representative and thus the outcome of the study may be less valuable or applicable. The population should perhaps consist of people from other backgrounds, living in Holland or even in Europe. However, other survey results show similarity:

> A recent survey amongst “2512 consumers in France, Germany, Italy, Spain, and the United Kingdom called ‘new European consumer survey on connected car data and privacy’ shows quite similar outcomes compared to the outcome of this thesis study” (Otonomo, 2020). The top reasons why drivers don’t want to share their data is trust (“I don’t trust companies to keep my data safe”), safety (“I don’t want to become a victim of identity theft” and “I’ve heard a lot of negative things about data privacy”) and transparency (“I am worried about how the data will be shared” and “I don’t want to be profiled”). A few other findings of this survey are that “the majority of consumers are interested in services based on connected car data”. 80% of the consumers would only consider sharing such data if there were incentives such as cheaper car insurance rates, preventing breakdowns, or free in-car services. As described, transparency, safety and trust about data are critical to earning consumer confidence. Sixty percent of respondents state that “it’s very important to be told exactly what data is being collected, how it is being used, and by whom” (Otonomo, 2020).

The comparability between the outcomes of the two surveys makes it fair to state that the results from this thesis study are applicable to a population of people between 18 and 65, living in the countries as mentioned above, including the Netherlands.

The prison panopticon by Bentham could be considered as mechanistic and inhumane. However the way modern technology is used nowadays makes it hard to ‘escape’ from the idea of a panopticon. Data generated by connected car can be beneficial, for instance in terms of convenience or service, but it can also harm the individuals’ privacy if not handled properly, for instance if not respected in accordance to the law. This could potentially lead towards a situation where a person has no intention to share data from a connected car. To investigate this further a case study could be performed in order to investigate how data generated by connected cars can be handled, stored and distributed with respect to security and the privacy of its owners. An interesting topic of study could be how to maintain ownership of personal data. A number of principles and techniques concerning data, as briefly described below, would be advisable to the ministry of infrastructure and water management and Rijkswaterstaat for further study. Results gathered from this thesis study could be used as a baseline or starting point for a new case study.

FAIR

The FAIR guiding principles were published in 2016 in the magazine Scientific data (Go-fair.org, 2016).

Figure 19, the FAIR guiding principles, source go-fair, 2016

The intention of the FAIR principles is to improve the findability, accessibility, interoperability, and reuse of digital assets:

Figure 20, Fair Principles, source: CCAFS CGAR, n.d.

Distributed data storage

Due to the vast volumes of data generated by a connected car, a data platform for connected cars must be capable for fast data transfer, scalable and inhabit fast processing performance. In distributed data storage the software controls the division, distribution, replication and rectification of data (Googlelinux, 2016). Compared to a traditional database solution, distributed database systems are cost efficient, more scalable, flexible, more reliable, higher available and the performance of the database system is improved. With distributed data storage the cost of hardware infrastructure is minimized and the storage capacity becomes almost endlessly expendable. Due to the ability to add storage real time, flexibility increases and due to a build in fault tolerance system, reliability and resilience increase. Distributed database systems work with a concept called a database link. The link forms the connection between two database servers. The concept provides client access to two physical databases as one logical database.

Digital Twin

Gartner defines a digital twin as a digital copy of a physical object (Gartner, 2017). A digital twin can replicate for example a car engine or even a city. In a digital twin data can be used to "create simulations that can predict how a product or process will perform" (TWI-globol, n.d.) and a digital twin can be integrated the internet of things. A digital twin works with sensors that collect data. This data is processed in a cloud environment and then compared (Forbes, 2017). In this way a digital twin can help companies enhance products, innovate products and improve the customer experience. Privacy within a digital twin solution for connected car users can possible be accomplished by applying a privacy enhancement mechanism (IEEE, n.d.). This mechanism uses a five step automated GDPR compliance check:

1. Stakeholders and assets are identified;
2. A vulnerability detection process of correlating data is executed to find unique values, like for example a combination of age, race and location;
3. Providing GDPR compliance through de-identification of personal data by replacing privacy data with fictional values;
4. Interpretation of the resulting data (sending consent requests to data subjects);
5. Data anonymization to minimize the privacy risks and protect subjects from privacy breaches.

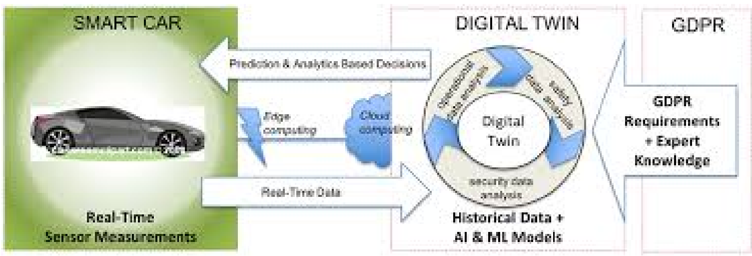


Figure 21, twin-based privacy enhancement mechanism for cars, source iot4cps.at

Security within a digital twin solution for connected car users can possible be accomplished by applying a digital vault (Johnsoncontrols, n.d.). In a digital vault all data is encrypted and protected by access control systems. The data stored in the digital vault can be masked. In this way people who need access to data can be prevented from also obtaining any personally identifiable information.

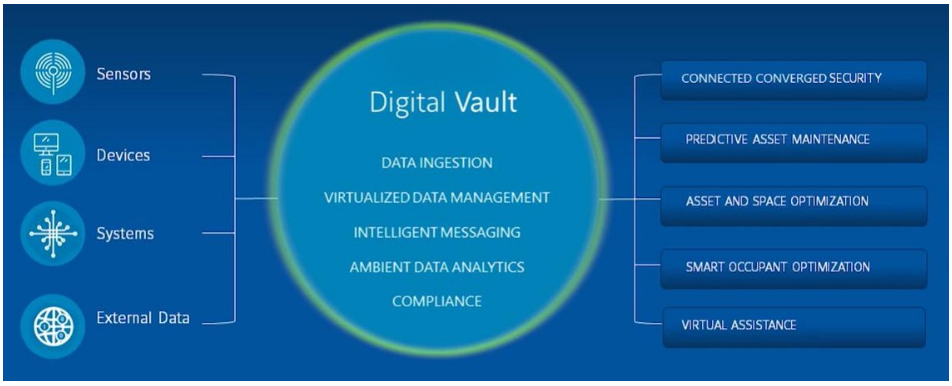


Figure 22, a Digital vault, source Johnsoncontrols, n.d.

The internet of things

The Internet of things can be explained as:

"an expanding collection of connected devices that send data across the Internet, where any object with embedded electronics that can transfer data over a network without any human interaction" (IBM, 2008). "The internet of things allows people and things to be connected anytime, anyplace, with anything and anyone" (Vermesan et al., 2009). The internet of things is built out of the sensors and applications we and the society use on a daily basis and the devices we own.

Gradually the internet of things may become more and more physical to its users. Therefor digital civil rights may become more intertwined with 'regular' human rights. This may contribute to our awareness of the risks we face with the potentially growing 'digitalisation' of our lives. It emphasises the cause for our privacy. The impact from the internet of things on our society is potentially unknown. Do smartphones and smartwatches change our behavior? Do they impact our privacy? Does it change the relationship between consumers and producers whereas ownership possible disappears and the manufactures updates for our connected devices could be provided to the extent of our lives?

It is a discussion well worth investigating. A future case study could investigate how to safeguard and manage (personal-) data from connected cars with a strong focus on the ownership of this personal data. The principles and techniques as briefly described above are relevant and usable and can be combined with the results from this thesis study.

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8. Addendum, survey

Enquete Connected Car

Een connected car is een auto die verbonden is met het internet. Steeds meer fabrikanten maken hun auto's tegenwoordig connected. Een nieuwe auto verzamelt allerlei informatie, zoals het brandstofverbruik, rijgedrag, snelheid en je locatie. De verzamelde data kan via het internet gedeeld worden met anderen. Denk hierbij aan de bestuurder van de auto, autofabrikanten, de garage, een verzekeringsmaatschappij of een alarmcentrale (in het geval van een ongeluk of pech). De verzamelde data kan nuttig zijn om bijvoorbeeld zuiniger of veiliger te gaan rijden of om de technische staat van de auto te monitoren. Het is zelfs mogelijk om te kijken waar je de auto hebt geparkeerd mocht je dat vergeten zijn. Een connected car is overigens niet per se een zelfrijdende auto.

Deze enquete vindt plaats in het kader van een master studie aan de universiteit Leiden. Het doel van de enquete is om een beeld te krijgen van de invloed van connected car technologie op het gedrag van de bestuurder.

De deelname aan deze enquete is vrijwillig en anoniem, jouw privacy is te allen tijde gegarandeerd. Kruis het onderstaande vakje aan om in te stemmen met deelname aan de enquete.

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1. Algemeen

1.1	Ik ben een		Man		Vrouw						
1.2	Mijn leeftijd		18-24		25-35		36-50		>50		
1.3	Migratieachtergrond		Ja		Nee						
1.4	Woonachtig in regio		Noord		Zuid		Midden		West		Oost
1.5	In bezit van een auto		Ja		Nee						

2. Ben je bekend met het begrip Connected Car?

2.1	Ja, daar weet ik wel wat van	
2.2	Nee, nog nooit van gehoord	

3. Verwacht je dat connected car technologie impact heeft op onderstaande gebeurtenissen en is deze impact belangrijk voor jou ?

		Impact		Belangrijk		
		ja	nee	Ja	Nee	Weet niet
3.1	Minder ongevallen					
3.2	Minder files					
3.3	Sneller op je bestemming					
3.4	Minder brandstof verbruik					
3.5	Lagere verzekeringspremies					
3.6	Minder privacy voor de bestuurder (locatie, snelheid)					

4. Hoe bezorgd is de maatschappij denk je over het gebruik van connected car technologie?

		bezorgd	Neutraal	Onbezorgd	Weet niet
4.1	Privacy (locatie, snelheid)				
4.2	Aansprakelijkheid				
4.3	Veiligheid van de techniek				
4.4	Afleiding voor de bestuurder				
4.5	Aanval van hackers				
4.6	Afhankelijkheid van het systeem				
4.7	Het niet werken van het systeem in onverwachte situaties				

5. Denk je dat mensen hun rijgedrag aanpassen als men zelf kan zien dat een andere manier van rijden of rijgedrag positief bijdraagt aan het milieu?

5.1	Ja	
5.2	Nee	
5.3	Weet ik niet	

6. Denk je dat mensen hun rijgedrag aanpassen als men weet dat iemand meekijkt?

6.1	Ja	
6.2	Nee	
6.3	Weet ik niet	

7. Zouden mensen bepaalde locaties gaan vermijden als iemand anders inzage heeft in waar ze zich op een bepaald moment bevinden?

7.1	Ja	
7.2	Nee	
7.3	Weet ik niet	

8. ls het mogelijk zou zijn, zou je dan invloed willen hebben op de te verzenden soort data vanuit jouw auto, denk hierbij bijvoorbeeld aan je locatie die je niet wil delen met anderen en je snelheid wel.

		Ja invloed	Geen invloed	Weet niet
8.1	Invloed op te verzenden locatie data			
8.2	Invloed op te verzenden snelheids data			

9. Als het mogelijk zou zijn, zou je dan invloed willen hebben op de ontvanger van verzonden data vanuit jouw auto. Wie mag wel of geen data van jou ontvangen (bijvoorbeeld de fabrikant van je auto wél en je verzekeringsmaatschappij niet)

		Ja invloed	Geen invloed	Weet niet
9.1	Invloed op de ontvanger van snelheids data (denk aan een lagere premie verzekering)			
9.2	Inloed op de ontvanger van mijn locatie data (denk aan privacy of gemak)			

10. Zouden mensen bereid zijn meer data te delen als ze controle kunnen uitoefenen op te verzenden of ontvangen data?

10.1	Ja	
10.2	Nee	
10.3	Weet ik niet	

11. Zouden mensen bereid zijn meer data te delen als er wetgeving bestaat die consumenten en hun persoonlijke data beschermd tegen misbruik door derde(n) ?

11.1	Ja	
11.2	Nee	
11.3	Weet ik niet	

12. Wat is voor jou in één woord het belangrijkste <u>nadeel</u> van het gebuik van een Connect Car?

12.1	Veiligheid	
12.2	Milieu	
12.3	Privacy	
12.4	Invloed op premie verzekering	
12.5	Geen mening	

13. Zou je connect car technologie zelf willen hebben als dat mogelijk is?

13.1	Ja	
13.2	Nee	
13.3	Geen mening	

14. Ben je bereid te betalen voor connect car technologie?

14.1	Ja	
14.2	Nee	
14.3	Geen mening	

15. Wat is voor jou in één woord het belangrijkste <u>voordeel</u> van het gebuik van Connected Car technologie?

15.1	Veiligheid	
15.2	Milieu	
15.3	Efficiency	
15.4	Invloed op premie verzekering	
15.5	Geen mening	