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# Creating and Appropriating Value from Connected Vehicle Data

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*Management and Economics of Innovation*

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# Abstract

As vehicles become connected to the internet and start collecting data, automotive OEMs become owners of a new asset, vehicle data, that can potentially be valuable. For this new potential value to become realized, a process of value creation where data is turned into something useful for somebody is needed. For OEMs not to let all value slip into the hands of other actors in the connected vehicle ecosystem, they also need to find ways of appropriating it. The purpose of this thesis is therefore to investigate how value can be created from connected vehicle data and how automotive OEMs can appropriate this value.

The study was performed in an exploratory and qualitative manner, where semi-structured interviews and industry reports were important sources of empirical data. With a deep understanding of the automotive industry, NEVS, an automotive OEM, provided a great source of primary data. The case of the automotive industry was compared with cases of how data has been used in other industries, revealing many “do's and don'ts”. The comparative cases, together with research on how data can be made valuable and more general theories on value creation and appropriation, were used to analyze the case of the automotive industry. Customizations, collaborations, and new ways of organizing the business were identified as important in creating and appropriating value from data.

The thesis concludes that automotive OEMs can appropriate the value of data by improving internal processes such as product development to lower the costs and/or create better vehicles; by enriching their vehicles with data-enabled services that improve the user’s or owner’s experience of the vehicle, giving OEMs additional revenue sources and/or strengthening their competitiveness; or by selling data to external actors that can benefit from connected vehicle data. Creating value from data require automotive OEMs to adopt more flexible and fluid processes. This includes looking beyond the resources of the own firm, by collaborating with both customers, suppliers, and competitors. Doing this can provide the company with new competencies and insights, that in combination with data can increase its competitiveness. Collaborating becomes an important part in creating value for companies outside their current value chain too, where automotive OEMs will need to package data in ways that make it attractive.



*Keywords: Data, digitalization, connected vehicles, value creation, value appropriation, co-creation, customization.*

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# 1 Introduction

This chapter introduces the thesis by first describing the background to the research topic and presenting the purpose and research questions, after which the structure of the document is described.

## 1.1 Background

Over the last decades, vehicles have continuously become more connected with its surrounding environment with the introduction of different communication technologies (Dorrell, Vinel, & Cao, 205). Connected vehicles today communicate with the driver, other vehicles, roadside infrastructure, and the cloud, and are able to optimize their own operation and maintenance and the comfort of passengers by using onboard sensors and internet connectivity (McKinsey, 2014; Center for Advanced Automotive Technology, n.d). This process through which the business of vehicle manufacturers is becoming more digital can be referred to as digitalization (Gartner, n.d.). An effect of digitalization and that vehicles are becoming increasingly connected is that they start collecting immense amounts of data about its own functions and about what happens inside and around it. Digitalization and data bring with it new business models and new opportunities to create value and generate revenues.

Going from a non-digital era into a digital era, many automotive OEMs are faced with challenges in adapting. Though many believe that data has the potential of bringing tremendous economic and societal value, it is not very useful in its raw form; a process of value creation is needed, where data is made useful by processing and combining it in the right ways (Esmeijer, Bakker, & de Munck, 2013). Furthermore, gathering, storing, and processing data is associated with costs that companies need to weigh against the potential income it can bring. Consultancy firm Frost & Sullivan (2017) predicts that as the automotive industry transitions from solely delivering products to increasingly delivering data-enabled services, more than one trillion USD can be added to the industry revenue pool by 2030. However, with industry entries from both new players and technology giants, it is still unclear what role automotive OEMs should take to appropriate as much of this new value as possible.

This thesis is written in collaboration with the electric vehicle manufacturer NEVS, which is developing connected and autonomous vehicles with a focus of providing solutions for shared mobility services. NEVS was founded in 2012 but has a strong automotive legacy as it to a large extent is built upon the remains of Saab Automobile. The collaboration with NEVS has provided the authors with valuable insights into the workings of an automotive OEM and has facilitated contacts with experts in the field of connected vehicles and vehicle data. However, the thesis goes beyond NEVS and aims to provide generalizable answers to questions that are shared by most automotive OEMs.

## 1.2 Purpose and Research Questions

The purpose of this thesis is to investigate how value can be created from connected vehicle data and how automotive OEMs can appropriate this value. In order to fulfill this purpose, three research questions are identified:

RQ1 What kind of data can be collected from a technical and legal point of view?
RQ2 How can value be created from connected vehicle data?
RQ3 How can value created from data be appropriated by vehicle manufacturers?

RQ1 is intended to provide an understanding of what kind of data that automotive OEMs can collect, which will be important in answering the two remaining research questions. RQ2 focuses on the process in which vehicle data is turned into something useful and valuable to someone, and RQ3 is concerned with how automotive OEMs can act to capture as much of this value as possible.

## 1.3 Report Structure

Chapter 2 contains an extensive review of relevant theories and literature on the subject of data and creating and appropriating value from it. This review constitutes the theoretical framework on which the continued report is based. Chapter 3 describes and evaluates the methodology that has been used working with the thesis. In chapter 4, the empirical findings from the study of the automotive industry is presented. In chapter 5, a line of comparative cases from other industries are presented, aimed to highlight how data has been used both successfully and unsuccessfully. In chapter 6, the empirical findings from chapter 4 are analyzed with the help of the theoretical framework and the comparative cases. Finally, chapter 7 concludes the thesis by answering the research questions and discussing its implications. Figure 1 depicts how the different chapters are connected.

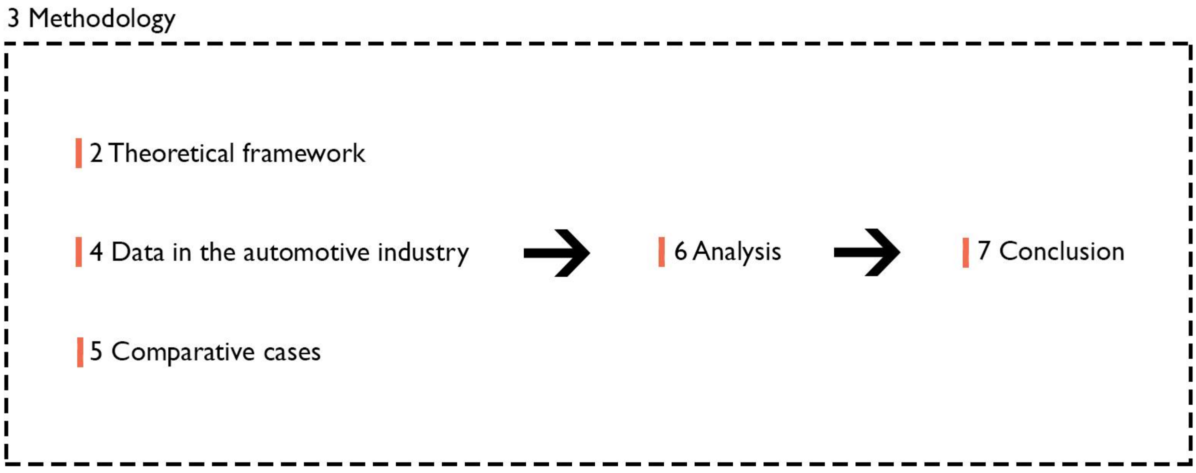


*Figure 1. A depiction of how the different chapters are connected.*

# 2 Theoretical Framework

In the following chapter, an extensive review of relevant theories and literature has been conducted. The chapter begins with a definition of what data is and a walkthrough of the trends that make managing data increasingly important, followed by a section introducing the fields of value creation and value appropriation. Section 2.3 and 2.4 then brings the different themes together to talk about how value from data can be created and appropriated. With theories on these subjects often speaking in general terms, an attempt will be made to connect theories to the automotive industry. Primarily, research from trusted academics with good amounts of citations on Google Scholar was used, and in cases where academic research was scarce, reports from well-known organizations, consultancies, and in some cases business journals, were used. The proposed framework lays the foundation on which the rest of the thesis is built, by providing guidelines for where attention is focused in both empirical and analytical chapters.

## 2.1 Data and Digitalization

Data is defined by Merriam-Webster (2018) as “information in digital form that can be transmitted or processed” and “information output by a sensing device or organ that includes both useful and irrelevant or redundant information and must be processed to be meaningful”. From its definitions, it thus stands clear that data is something that after its collection needs to be processed to become meaningful and valuable to somebody. With data and digital technologies becoming an increasingly important part of the business of vehicle manufacturers, it is clear that the industry is in a process of digitalization. Gartner (n.d.) defines digitalization as “the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business”. It thus stands clear that manufacturers need to adapt accordingly in order to seize the opportunities that data brings.

### 2.1.1 Trends in Data and Digitalization

Internet of Things (IoT) is one of the primary drivers of digitalization (Lewis, 2017). IoT refers to the process in which things, e.g. cellphones, coffee makers, or vehicles, become connected to the internet (Morgan, 2014). When products and services become digital and internet-based, data about the product or service itself and about the customer becomes available to companies providing these products and services (EY, 2011). Connected vehicles are equipped with hundreds of sensors, integrated with a great amount of smart technologies. According to Ahmed and Kapadia (2017) Ford Motor Company collects a few hundred gigabytes of data per vehicle per year, which includes over three billion data records. The large volumes of data, made possible by internet-enabled devices, is commonly referred to as big data (EY, 2014).

For big data to provide valuable insights that relate to consumers, productivity, profit and performance, it needs new, innovative and scalable technology to help collect, store and analytically process it (EY, 2014). In manufacturing companies, big data help enable new functionality, greater efficiencies, increasing reliability and ways of optimization that increase the value that companies can deliver to customers (Porter & Heppelmann, 2014). Thus, how the new amount of data is utilized and managed becomes strategically important. In addition to the strategic challenges, there are legal challenges that needs to be considered in order to minimize risks of failure (EY, 2014). This is partly due to changing regulations and the uncertainty of the future legislative environment.

Weill and Woerner (2015) write that as industries become increasingly digital, industry barriers break down and long-successful business models get destroyed. Industry incumbents become threatened by companies from other industries that many times have existing relationships with their customers. For this reason, the authors recommend companies to assess where potential external threats might come from and formulate strategies to handle them. On the other hand, Grant (2016) writes that "the greater the rate of change in a firm's external environment, the more likely it is that internal resources and capabilities rather than external market focus will provide a secure foundation for long-term strategy" (p. 116). He suggests that especially in fast-moving, technology-based industries, firms should focus on doing what it does best rather than trying to chase after market trends. Thus, one of the strategic challenges for vehicle manufacturers is trying to find out what their role should be in this new and digital business.

### 2.1.2 Value of Data

Before diving deeper into how value can be created from data, we will first put emphasis on which view of value that we adhere to. Value has been defined widely differently in literature, with Özdilek (2016) stating that is an elusive concept. Value can be described as the usefulness that is subjectively perceived by the individual end consumer (Hallberg, 2017) or simply as making an actor, such as the customer, "better off" (Grönroos, 2017). Further, the definitions seem to vary across different disciplines (Vargo, Akaka & Vaughan, 2017). We use a definition of value by Bowman and Ambrosini (2000), stating that a resource is valuable either if it enables customer needs to be better satisfied or if it enables a company to satisfy needs at lower costs.

In the age of big data, the full value of data is not obvious. Data is different to the usual resources companies use, being a non-rivalrous good that can be used over and over again (Mayer-Schönberger & Cukier, 2017). Seeing infinite potential uses, Mayer-Schönberger and Cukier (2017) term the potential value from all potential uses the *option value* of data, implying that the cost of storing data could be viewed as an option that in the future can bring significant value. Remembering from the definition of data that it is not meaningful until it has been processed, a value creation process where raw data is refined into knowledge or actionable insight is needed for the potential value to be realized. In line with this, Schlosser (2018) says that the value of data, unlike e.g. oil, does not grow by simply accumulating more of it. Instead, it is generated through analytics and combinations of different data sets. He therefore recommends governments and organizations to stop hoarding their data in locked up silos.

## 2.2 Value Creation and Appropriation

In the strategic management literature, a distinction is made between value creation and value appropriation, or value capture. The one that actually creates value from a set of resources is not always the one that gets to benefit from it since it is often lost or has to be shared with other stakeholders, e.g. employees, competitors or society (Teece, 1986; Lepak, Smith, and Taylor, 2007). Central to both value creation and value appropriation are business models, that Chesbrough and Rosenbloom (2002) state are what connects technical potential with the realization of economic value. This section therefore introduces the concepts of value creation and value appropriation, as well as relevant trends in business models.

### 2.2.1 Value Creation

Value creation refers to the process through which resources are used to deliver a value to someone (Hallberg, 2017). Value is created by individuals, organizations or societies and what this process looks like depends on which of these three levels of analysis one chooses to focus on (Lepak et al., 2007). For individuals the process is about creative acts of developing a new product or process and individual attributes such as ability, motivation and intelligence are important. On the societal level, macroeconomic conditions such as laws and regulations restricting or encouraging innovation and entrepreneurship is in focus. On an organizational level, the process consists of things such as knowledge creation, innovation, and management. Since this thesis focuses on the firm level and does not intend to come up with regulatory recommendations, focus will here be on the organizational level.

As mentioned, a central theme to organizational value creation is innovation. The OECD (2005) distinguish between four different types of innovations: product innovations, process innovations, marketing innovations and organizational innovations. Product innovations include both entirely new goods and services and significant improvements to existing ones. Process innovations refer to significant changes in production and delivery methods, organizational innovations represent implementation of new organizational methods, and marketing innovations concern the implementation of new marketing methods i.e. product design, packaging, pricing etc. Thus, an innovation does thus not necessarily have to be a new product bringing in new revenue but can also be more internally focused and of a cost-reducing nature.

### 2.2.2 Value Appropriation

Teece (1986) lays the foundation for the academic study of value appropriation, describing how an innovator's ability to capture the profits generated by an innovation is dependent upon *appropriability regimes*, i.e. environmental factors such as the nature of the technology and the legal instruments that can be used to protect the innovation, and the extent to which *complementary assets,* i.e. assets that increase the value of the focal innovation, technology or asset (e.g. distribution channels), are present. Holgersson, Granstrand, and Bogers (2018) elaborate on the work of Teece (1986) and suggest that substitute assets must be considered as well as complementary assets, since they also have an effect on how much of the value of a focal technology that can be appropriated.

Depending on the specific characteristics of different industries, the relative importance of the different categories identified by Teece (1986) varies. In a few industries, a patent or a trade secret may let the innovator capture a big part of the total profits generated, whereas in most cases a patent can easily be invented around and therefore provide futile protection against imitators (Teece, 1986). In such a case of weak appropriability regimes, access to complementary assets instead become important. A choice then has to be made of whether the complementary assets should be accessed by contractual arrangements or via integration of the complementary asset into the firm, depending on the level of specialization and criticality of the asset in question. Who can benefit from the innovation thus depends on contractual conditions and the relationships between innovator and holder of complementary assets. With data being an intellectual asset, there is indeed some legal protection (see section 2.4.1). However, similar to how it is often possible to invent around a patent, one could argue that a company in need of data could try to gather the data themselves and build a database of its own, instead of obtaining the data by e.g. licensing it in from another data holder. The strength of the appropriability regime is then decided by how difficult it is, or how much effort it takes, to gather the data in the specific situation. An assessment of the appropriability regime thus has to be made on a case-by-case basis for every specific set of data.

Jacobides, Knudsen and Augier (2006) shift the focus from the dyadic relationship between innovator and holder of complementary asset to industry-wide *architectures,* and introduce *architectural advantage* as a way for firms to appropriate value. A firm can get architectural advantage by shaping standards and increasing mobility in complementary assets by encouraging competition in adjacent segments of the value chain while restricting mobility and competition in their own sector. An example is the PC industry in which Intel and Microsoft have successfully managed to gain architectural advantage by promoting fierce mobility and competition among PC manufacturers, while protecting their own positions and managing to become the "guarantors of quality" in the PC market.

### 2.2.3 Business Models and Platforms

For companies, the concepts of value creation and value appropriation become linked together in the form of a business model. Osterwalder and Pigneur (2010) define a business model as "the rationale of how an organization creates, delivers, and captures value" (p. 14). They also outline a framework to describe the business model of a company, in the shape of nine blocks that show how the company intends to make money (see Figure 2 for a depiction). These nine blocks are:

1. Customer Segments, describing who the customers that the company serves are.
2. Value Propositions, describing what customer needs that are satisfied.
3. Channels, describing how value is delivered to customers.
4. Customer Relationships, describing how relationships are established and maintained.
5. Revenue Streams, describing how the company makes revenue and captures value created on the platform.
6. Key Resources, describing the assets required to offer and deliver value.
7. Key Activities, describing the activities required to offer and deliver value.
8. Key Partnerships, describing activities and resources that are outsourced or acquired from outside the company.
9. Cost Structure, describing the costs associated with running the business.

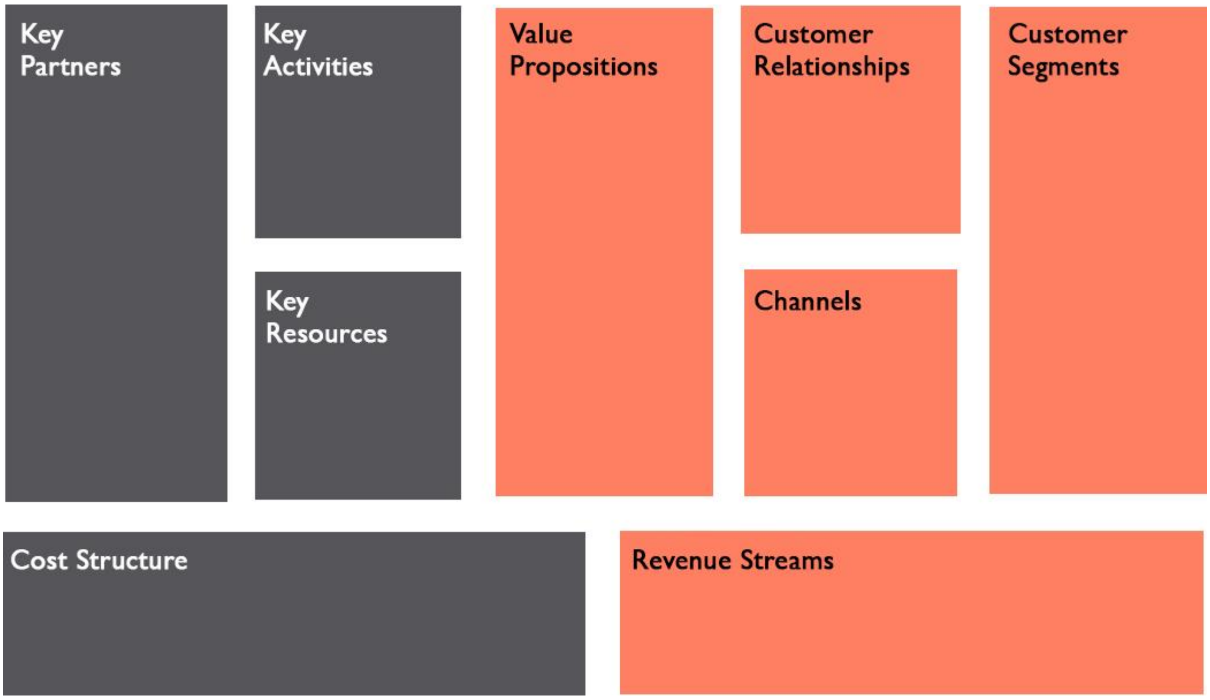


*Figure 2. The Business Model Canvas. Adapted from Osterwalder and Pigneur (2010).*

Business models in the automotive industry have traditionally focused on delivering vehicles as complete products. Faced with digitalization, Capgemini (n.d.) stress the importance for automotive incumbents to transform their product-oriented strategy to a customer and service-oriented strategy. Ladhe, Magnusson and Nilsson (2013) argue that as the institutional logic of an industry changes, e.g. changing focus from delivering products to delivering services, business models need to change accordingly. For this reason, platforms, rather than products, have become a bigger focus for companies, and especially so for companies operating in digital markets (Grant, 2016). In figuring out how connected and autonomous vehicles will generate profits, platform business models have been getting increased attention, with the showcased success of e.g. mobility services such as Uber and DiDi (Hars, 2017).

In the automotive industry, a platform has traditionally been referring to the concept of letting several car models share the same underlying technology, reducing development costs and allowing for economies of scale (Hars, 2017). In more general terms, platforms refer to “technologies, products or services that create value primarily by enabling direct interactions between two or more customer or participant groups” (Hagiu, 2014). Who these participant groups are differ from platform to platform, e.g. AirBnB links house owners to people looking for accommodation, Uber links car drivers to people looking for rides, and Apple iOS/App store links app developers to smartphone users. Thus, a platform business model enables a company to serve a multi-sided market, where both suppliers of the products or services on the platform and the buyers of these can be considered customers to the platform owner. In markets where competition is among different platforms, network effects, i.e. the tendency for both participant groups to gather around the market-leading platform, are important (Grant, 2016). A result of strong network effects is winner-takes-all markets where a market leader takes most of industry revenues and makes most of the industry’s profits.

## 2.3 Creating Value from Data

LaValle, Lesser, Shockley, Hopkins, and Kruschwitz (2011) found that businesses with well-developed use of data analytics in internal activities such as operations, production, and product R&D are outperforming businesses with less developed use of analytics. They also found that the biggest inhibitors to using data analytics successfully are managerial and cultural rather than related to technology or access to data. McAfee and Brynjolfsson (2012) reached the same conclusion and found evidence that companies in the top third of their industry in the use of data-driven decision making were, on average, 6% more profitable and 5% more productive than their competitors. In line with the findings of both McAfee and Brynjolfsson (2012) and LaValle et al. (2011), much literature on the subject of creating value from data tend to focus on managerial and cultural requirements.

### 2.3.1 Managerial and Cultural Requirements

McAfee and Brynjolfsson (2012) identify five managerial requirements for companies to be able to create value from their data. First, what sets successful companies apart from less successful ones are leadership teams that set clear goals, define what success looks like, and ask the right questions. Second, to be able to extract valuable insight from data, companies need skilled data scientists, which can be hard to find because their value increase as data becomes cheaper. Third, companies need the right technologies and skills to handle big data, something that is new to most IT departments. Fourth, companies need to put the relevant decision rights and the right information in the same place. The organization needs to be flexible and let the people who understand the problems be brought together with the right data and people with the right problem-solving techniques. Fifth, many times companies need to change their cultures and stop acting on hunches and instincts, and start acting on what they really know. LaValle et al. (2011) highlight that for analytics-driven insights to actually trigger new actions across the organization, they must be closely linked to business strategy, easy for the users of the insight to understand, and embedded into organizational processes so that action can be taken at the right time.

Manzi (2012) points out the benefits of the concept Test & Learn, involving trying out new ideas in small parts of the business and making predictions based on these tests. Manyika et al. (2011) also suggest that data lets organizations experiment with new ways of doing things, noting that the growing number of sensors and consequently data can help enable e.g. comparative effectiveness studies and thus expose variability and improve performance. One reason for conducting experiments is that the increase in amount of data means that models built to handle these much larger datasets are increasingly difficult to evaluate and change due to their complexity (Manzi, 2012). Intuition and experience are not sufficient to determine the causality needed to with enough reliability guide actions regarding big data.

As digitalization and data demand traditional manufacturing companies, such as automotive OEMs, to change their cultures and become more flexible in how they work, Leybourn (2013) recommends them to borrow practices from the IT industry. He specifically describes how manufacturing companies can benefit from implementing work processes inspired by the principles of Agile Software Development. Agile Software Development is based on collaboration between self-organizing, cross-functional teams (Agile Alliance, n.d), and contains a range of different techniques for how work is organized, such as Scrum, Extreme Programming, Test-Driven Development, and Kanban (Leybourn, 2013). Leybourn (2013) describes how an experimental vehicle manufacturer created a research, design, and production cycle in which changes could be made to the vehicle every week, thanks to high degrees of modularity allowing for rapid iterations and experimentation as well as concurrent engineering. He claims that implementing an Agile business management work model include benefits such as more accurate estimation techniques that improves forward planning and reduces overtime, higher quality outcomes through embedded quality control processes, simplification of overall work, and greater customer satisfaction through early, regular and targeted delivery.

### 2.3.2 Collaborative Approaches

With advances in data processing, Manzi (2012) argues that new digital data sources are becoming available, and that companies that integrate these new data sources into analyses will analytically outperform systems which rely only on internally generated company data. Further, Manyika et al. (2011) stretch the importance of making data more timely and easily accessible to stakeholders that can gain value from it. This transparency can be of value for both customers as well as internal functions such as R&D, engineering and manufacturing, and enable concurrent engineering improving quality and reducing time-to-market. Both Manzi (2012) and Manyika et al. (2011) thus suggest that creating value from data requires new ways of interacting with stakeholders.

Paper, Ugray, and Johnson (2014) state that companies that are new or have little experience with big data can benefit from collaborating with others with more expertise in big data analytics. The argument is made that such collaborations can provide quick access to experts in analytics. Del Vecchio, Di Minin, Petruzzelli, Panniello, and Pirri (2018) claim that an open approach with more porous boundaries between companies is necessary to successfully manage and create knowledge and innovation from the ever-increasing amounts of data generated by different sources. Altogether, mentioned literature (Paper et al., 2014; Del Vecchio et al., 2018) implies that companies inexperienced with creating value with services from data, to a higher degree than others, can benefit from collaborating with other actors.

According to Prahalad and Ramaswamy (2004) the enablement of co-creation is important for a company to discover new competitive advantages. It involves a joint creation of value by the customer and the company, with joint problem solving and making a service that better suits the customers' needs. Co-creation focuses on the dialog between the company and the customer, compared to a company trying to please a customer. When talking about creating value for customers with services, Vargo and Lusch (2008) argue that the customer is always a co-creator. Xie, Wu, Xiao, and Hu (2016) identify four types of data generated by the customer, which constitute a resource base for customers to participate in value co-creation. Transactional data is one of the most frequently used types of data and comes from the customer's purchasing behavior. Transactional data includes price, product category, numbers, location, and demographics. Communication data comes from the interactions the customer has when purchasing, participative data comes from when the customer is helping the company make a (re-)configuration by giving their opinion, and transboundary data is generated by customers when moving between different service ecosystems and thus facilitating the sharing of knowledge across these different ecosystem boundaries.

### 2.3.3 Customization and Personalization

Paper, Ugray, and Johnson (2014) argue that with the increased amount of information about customers that big data brings, companies can make more refined customer segmentations. Being able to tag customer profiles, either in real time or uploaded, makes it possible for companies to understand what customers really want and enjoy. Franke, Keinz, and Steger (2009) define customization as the process of treating customers as unique individuals in offering products and services. With data, Manyika et al. (2011) argue that companies are able to segment populations through combinations of attributes, e.g. shopping attitudes and demographics. Pine, Peppers & Rogers (1995) argue that the reason for why customization generally creates a competitive advantage is that when firms customize they often engage in extensive communication with customers. Because of this, these firms will gather extensive proprietary information about customers, making it costlier for customers to switch to competitors.

When you combine sufficient data sources, from internal and external data sources, you are able to achieve mass customization (van Rijmenam, 2018). Kull (2015) describes mass customization as the approach of combining customization with the low unit costs of mass production. Kratochvíl and Carson (2005) argue that a way of achieving mass customization with computer software is by automating a service. In close relation to this is the concepts collaborative and adaptive customization. In collaborative customization the focus company works together with a customer to specify the needs, and in adaptive customization the offering is capable of matching a variety of needs by adapting itself (or by being easily adapted by the customer). Though these terms are often used to describe customized products, Kratochvíl and Carson (2005) argue that they help understand customization of services too, even though they often in these cases are intermixed.

An often overlooked consequence of mass customization is the phenomenon of mass confusion (Huffman & Kahn, 1998). With more parameters that have to be specified by users or more products to choose from, it will be less probable that customers make a purchase decision. Personalization is the specific tailoring of a product or service to an individual user's specific needs and preferences, based on personal data (Tiihonen & Felfernig, 2017). Personalization can be a way of helping customers overcome the challenges of mass confusion, by demanding less interaction efforts for customers to configure services or products they are interested in and providing the recommendation of new relevant products and services a customer never thought of.

## 2.4 Appropriating the Value of Data

Wixom and Ross (2017) identify three approaches for companies to appropriate the value of their data. The first and most straightforward approach, but often underestimated by bosses, is to use it in improving internal business processes and decisions. The second approach is to enrich core products or services by wrapping them in data, which can be used as a means to generate sales increases, higher prices and deeper customer loyalty. The third approach, and according to the authors the hardest way to monetize data because it requires completely new business models, is to sell the data itself to new or existing markets. Faktor (2015) goes one step further and dissuades companies from trying to sell data since the potential benefits seldom are worth the risks of disgruntling customers whose data is sold, and that there is a significant opportunity cost related to serving somebody else instead of trying to figure out how the data can be used internally or to improve the companies' own products. Wixom and Ross (2017) say that companies can choose to pursue more than one approach at the same time, though each approach requires specific organizational changes and engagement in management activities. Figure 3 summarizes the three approaches put forward by Wixom and Ross (2017).

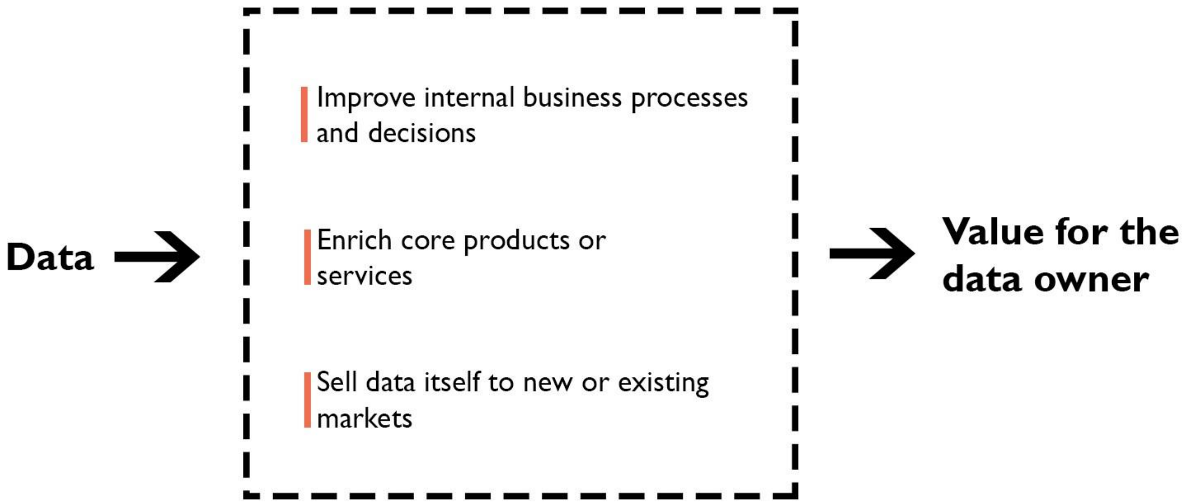


*Figure 3. Wixom and Ross' (2017) three approaches for companies to appropriate the value of data.*

Mayer-Schönberger and Cukier (2017) write that the most obvious possibility for a data holder to capture value from its data is to use it internally, but that only doing so might hinder companies from uncovering all potential valuable uses of its data. They therefore suggest that data holders should license its data to third parties in arrangements that pay them a percentage of the value extracted rather than fixed fees, which resembles how intellectual property deals are often struck in the biotechnology sector and gives all parties incentive to maximize the value created from the use of the data. The authors also recommend data holders to not grant licensees exclusive access to their data and predict a norm of "data promiscuity". To stress the importance of being meticulous in one's treatment of data in collaborations with other companies, Mayer-Schönberger and Cukier (2017) describe how Google entered the field of speech recognition in 2007 by licensing in technology from Nuance. The contract between the firms did not specify who got to keep the voice-translation records, so Google kept it for itself. Analyzing this data turned out to be very valuable in developing a new speech-recognition service and improving it. When Nuance recognized its blunder, it started striking deals with other actors where it got to keep the data in order to catch up with Google.

Suggestions put forward by Mayer-Schönberger and Cukier (2017) imply that data can and should be treated similar to how other forms of intellectual property are used. This makes it relevant for data holders to consider the use of methods from the field of open innovation and learn from the concepts of value appropriation theory, in which research has previously been most focused on other types of intellectual property, e.g. patents. Before further elaborating on how these methods and concepts can useful when managing data, however, a legal review of data as intellectual property is made.

### 2.4.1 Data as an Intellectual Property

In a report from 2017, British law firm Allen & Overy (Parker, Shandro and Cullen, 2017) identifies increased complexity in questions regarding ownership of data and other forms of IP as collaborations and partnerships become more frequent, as one of the biggest legal issues facing the connected and autonomous vehicle industry. A single piece of data can not really be owned, but a collection or aggregation of data, or database, can be (Joyce, 2017). In the European Union, the Database Directive of 1996 sets the rules for how databases can receive legal protection (European Commission, 2016). Databases can be protected by both copyright law, in the case that the arrangement and structure of the contents can be considered innovative or original, and by a *sui generis* database right that protects the investments of time, money and effort of a database producer regardless of the originality of the work. This sui generis right is unique to the EU and makes protection of databases stronger in the EU than in e.g. the U.S. where copyright law is the only applicable tool (Bitlaw, n.d.).

The European database right will fall to the maker of the database, whose identification is not necessarily easy in the age of big data where many actors are often involved in some way in the collection and storage of the data (Joyce, 2017). The maker will be the actor who made the commercial decision to collect the data and made the investment to do so, i.e. not necessarily the one who actually made the collection or presentation of the data. If more than one actor made the commercial decision and assumed the risk of the investment, the right may be jointly owned. Who gets ownership of a database with many actors involved is therefore not entirely easy to say, why Joyce (2017) argues that contractual provisions between actors will be more important than ever going forwards.

### 2.4.2 Appropriating Value from Collaborations

With scholars emphasizing openness and collaboration as key factors in both creating and capturing value from data, the scholarly field of open innovation becomes interesting in the context of this thesis. With open innovation, Chesbrough (2003) stresses that companies should not limit themselves to their own channels when commercializing intellectual property, but also find ways to profit from others' work on that property through agreements or joint ventures. With open innovation, companies can commercialize both own ideas as well as innovation drawing on the knowledge from a broad range of external actors, including suppliers, customers, research institutions and competitors.

Chesbrough (2003) suggests that businesses can be located on a continuum from essentially closed, where all ideas are generated and developed internally (e.g. the nuclear industry), to completely open, where networks of partnerships and alliances between different actors are the most prevalent way of innovating and the mobility of the workforce is high (e.g. Hollywood). However, as Enkel, Gassmann and Chesbrough (2009) imply, it is not obvious where on this continuum that a company should locate itself. Too much openness can lead to loss of control and core competencies and thereby hurt long-time innovation success. On the other hand, a closed innovation approach leads to too long innovation cycles and time to market.

The authors therefore suggest that the core challenge for companies is to strike a proper balance between using every available tool, internal or external, to successfully create products and services faster than competitors, while at the same time building competencies and protecting intellectual property.

Enkel et al. (2009) describe how open innovation contains three core processes. First, the *outside-in process* refers to enriching the focus company's own knowledge base through integration of suppliers, customers and external knowledge sourcing, which can increase the company's innovativeness. Second, the *inside-out process* is focused on earning profits by transferring ideas to the outside environment. Doing this, ideas can be brought to market faster than they could have through internal development. This can be done through e.g. out-licensing, joint ventures, or spinoffs, that generate additional streams of income. Third, the *coupled process* refers to co-creation in a give and take manner with complementary partners through cooperation, alliances, and joint ventures. The coupled process can in this way be viewed as a combination between the first two processes, and a way for companies to jointly develop and commercialize innovation.

Holgersson and Granstrand (2017) state that as innovation becomes more open and collaborative, formal intellectual property rights become even more important than in the age of closed innovation since strong IP rights are essential for managing relationships and maintaining bargaining power over collaborators. They also identify a line of generic strategies for how a firm's technology can be commercialized, which can then be used to decide on IP strategies for the firm's different intellectual properties that the technology consists of. Similar to how Chesbrough describes different levels of openness in open innovation, these strategies are placed on a continuum from closed to open. Starting from the most closed strategy and moving towards the most open, the generic strategies are: internal exploitation, where direct investment in production and/or marketing of products is made; creation of innovative projects or firms; joint ventures; technology out-licensing; and other forms of technology sales, e.g. contract R&D.

# 3 Methodology

In the following chapter, the research methodology of the thesis is outlined. First, the research strategy and design is discussed, whereafter the research process is explained. Thereafter, the process of the data collection in this thesis is presented before finally elaborating on the research quality and critique of the methodology.

## 3.1 Research Strategy and Design

A common distinction of research strategies is often between those that are qualitative and those that are quantitative. This thesis has largely been influenced by the strategy of conducting qualitative research. Quantitative research focuses on numeric and unchanging data, using structured research instruments that gather larger sample sizes, representative of a whole population (Babbie, 2010). In contrast to this, qualitative research emphasizes words rather than quantification in the use of data and often aims to understand data in its context (Bryman, 2012). Focusing on the complex nature of data and understanding how it is disrupting the context of automotive OEM, a qualitative research was considered to provide a better end result. Further, a qualitative approach can be useful when aiming to understand a certain situation where little is yet known (Strauss & Corbin, 1990; Hoepfl, 1997; Fraenkel & Wallén, 1996). Since certainty and objective truths about the topic of this thesis has yet to evolve, the choice of a qualitative approach is further strengthened.

In addition to the distinction of qualitative and quantitative research strategies, an important decision is choosing research design (Bryman, 2012). Research design is defined as providing a framework for both the collection and analysis of data. Methods, in turn, concern the actual implementation of a chosen design or designs. In literature there are many ways to classify research design and the distinctions can therefore be viewed as artificial (Jalil, 2013). However, Bryman (2012) gives a description of what he considers to be five different research designs. Using his terminology, one could argue that this thesis uses a single-case study approach, as the focus is on case of the automotive industry.

## 3.2 Research Process

The research process consisted of three different parts; planning, data collection, and analysis and synthesis. These different parts were taken on in a non-linear manner, with feedback in between them affecting the development of each part. The process can be seen depicted below in Figure 4. In each part the different assignments were also taken on non-linearly. Of the three different research questions posed in section 1.2, the first one was answered in the data collection and the two others in the analysis and synthesis.

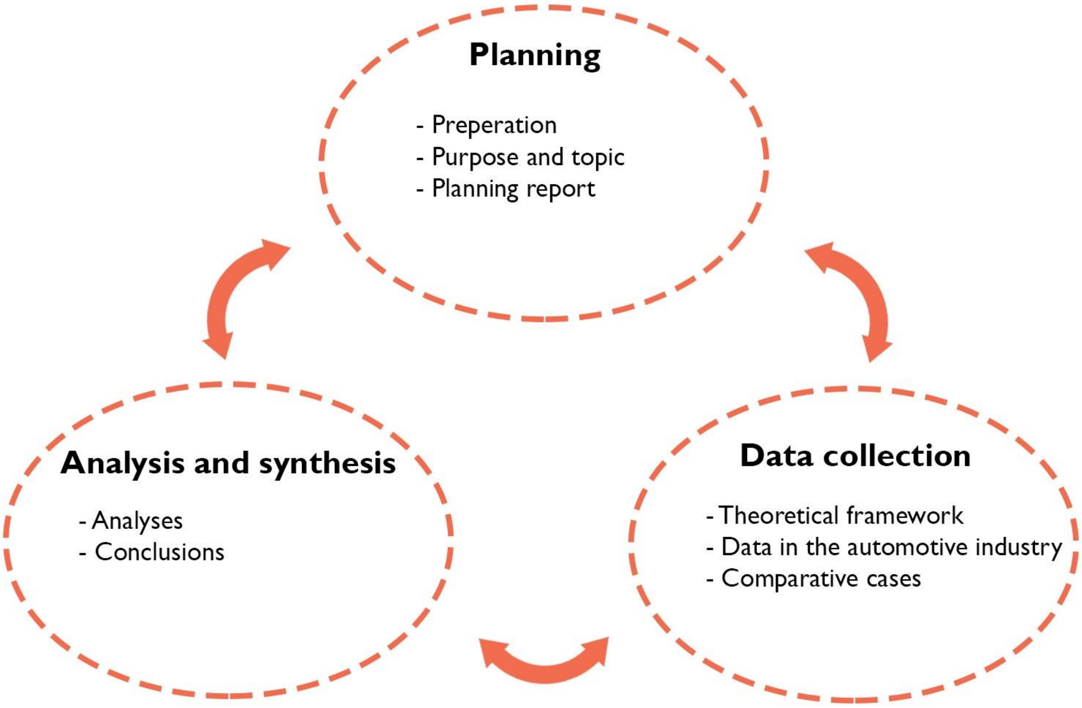


*Figure 4. An overview of the different parts included in the research process of this thesis.*

The planning part included first approaching NEVS, to gain an understanding of potential research areas of interest. After this a purpose and research questions were presented to both NEVS and Chalmers, to gain feedback. The thesis was approached with a wide scope in an exploratory manner, to gain as much of an understanding as possible of data within the automotive industry. Lastly in the planning part, a planning report was compiled to outline the background, purpose, research questions, research methodology, and time plan.

After the initial outline and introduction to the topic, the research proceeded to the part of data collection. A theoretical framework was built using books, published articles from academics, and reports from e.g. consultancy firms. The two empirical sections, data in the automotive industry and comparative cases from other industries, were based on data collected from both primary and secondary sources, being mainly interviews and reports from e.g. consultancy firms.

The final part of the thesis, the analysis and synthesis, begun with a categorization of the empirical findings into three different sub-categories. In each of these categories an analysis was made, with the theories and literature compiled in the theoretical framework. The last chapter, conclusions, then outlined the generated conclusions and a short discussion.

## 3.3 Data Collection

During the work with data collection, data has been collected from both primary and secondary sources of data. Interviews were used to collect most of the primary data, described more in-depth below. To get more of a breadth in the study, secondary data from literature helped to complement the primary data from interviews in e.g our comparative cases. As Bryman (2012) writes, case studies are usually made with primary data. However, he also argues that secondary data can offer numerous benefits to students carrying out a research project, such as providing high-quality data for a significantly smaller cost. Thus, we argue that the choice of secondary data as a complement to the primary data in this case is justified. In the following three subsections, data collection will be dealt with.

### 3.3.1 Data in the Automotive Industry

The main focus of this thesis is to outline the case of how data is and can be used in the automotive industry. In turn, this is made by making a case study of NEVS, talking with industry experts and looking at relevant reports on the subject of data within the automotive industry, relating to value creation and appropriation. In exceptional cases, on less researched subjects, data from organization websites has been collected. We argue that the usage of data within NEVS can be representative for many other actors in the industry. In combination with the reports and interviews with industry experts, the case of NEVS therefore provide a good picture of how data is used in the automotive industry. Through the process of data collection, potential customers of vehicle data have been identified. This has led us to also conduct interviews with some relevant organizations.

All interviews carried through were semi-structured interviews, which Bryman (2012) describes as an approach where a series of questions are prepared, but the sequence in which they are asked can be altered and interesting subjects can be elaborated on further by adding questions. Bryman (2012) writes that case studies can favor from semi-structured interviewing, because this method can help generate a detailed examination of a case. Semi-structured interviews are also in line with a qualitative strategy, which suggests a relevant implementation of the research strategy has been made. Selecting which individuals to interview, purposive sampling was used, where interviewees were selected based on their relevance to the research purpose. This method is also in accordance with the qualitative approach.

During the interviews, sound recording equipment was used, which Braun and Clarke (2013) note is a way to minimize risks of answers being misheard or misinterpreted. Extracting data from the interviews, thematic analysis was used. Braun & Clarke (2006) describe thematic analysis as a method that involves identifying, analyzing and reporting themes (patterns) within data. In accordance with the thematic analysis the transcribed interviews were coded, which is a categorization that is done after interviews to identify themes (Bryman, 2012). Table 1 below presents an overview of the interviews conducted throughout the thesis work, which also aims to justify how each interview has contributed to the purpose of the thesis (see the column for subject). For the specific topics discussed in each interview, see the Appendix.

| ID | Title and company/organization | Subject | Date | Duration |
|---|---|---|---|---|
| | *NEVS* | | | |
| 1 | Car Connectivity Manager at NEVS, "the technical expert" | Technical aspects of data collection and usage | 2018-02-12 | ~ 1 hour |
| 2 | Business Development Manager at NEVS, "the legal expert" | Legal aspects of data collection and usage | 2018-02-12 | ~ 1 hour |
| 3 | Vice President Product Strategy & Planning at NEVS | Collecting data and creating value from it | 2018-02-12 | ~ 1 hour |
| 4 | Attribute Performance Manager at NEVS, "the product development expert" | Using data to make internal improvements | 2018-04-11 | ~ 1 hour |
| | *Industry experts* | | | |
| 5 | Postdoctoral Researcher at Göteborgs Universitet, "the data researcher" | Usage areas of data | 2018-03-02 | ~ 1 hour |
| 6 | IP consultant at Konsert Strategy & IP, "the IP expert" | Data as an intellectual property | 2018-04-11 | ~ 1 hour |
| | *Potential customers* | | | |
| 7 | Portfolio Manager in Research and Innovation at Trafikverket | Usage areas of data | 2018-03-26 | ~ 1/2 hour |
| 8 | Manager of Geodata Department at Stadsbyggnadskontoret Göteborg | Usage areas of data | 2018-03-26 | ~ 1/2 hour |
| 9 | Climatologist at SMHI | Usage areas of data | 2018-03-26 | ~ 1/2 hour |
| 10 | Traffic Analyst at Trafikkontoret Stockholm | Usage areas of data | 2018-03-27 | ~ 1/2 hour |
| 11 | Urban Planning Manager at Trafikkontoret Göteborg | Usage areas of data | 2018-03-29 | ~ 1/2 hour |

*Table 1. A summary of conducted interviews and how they have contributed to this thesis.*

### 3.3.2 Comparative Cases

With literature exploring the specific subject of value creation and appropriation of data being scarce, comparative cases provided an additional source of data. The process through which cases were selected was the same as the process used for selecting interview subjects, purposive sampling. This means that cases were selected based on their relevance to the research purpose. Some of the cases we have come across during the course of the thesis, and other cases were suggested to us by our tutor from Chalmers and interviewees from NEVS. Additionally, most cases were selected on the basis of them concerning well-known companies that many are familiar with. Retrieving information about the comparative cases, we were able to use primary data in some of the cases, where information was readily available to get directly from the organization or company examined. In other cases, secondary data was used. The choice of having comparative cases from other industries is also supported by Enkel, Gassmann and Chesbrough (2009), claiming that the growth of internet technology is making companies in other industries become increasingly important sources of innovation.

## 3.4 Research Quality

In this section we elaborate on how the research quality of the thesis has been assured. Much of the literature aiming to assess quantitative research quality base their analyses on reliability and validity (Bryman, 2012). However, scholars seem to have different opinions on the subject of judging qualitative research quality. Some scholars have criticized the applicability of using traditional quantitative concepts, such as reliability and validity, to assess qualitative research (Lincoln and Guba, 1985; Stenbacka, 2001). Some writers have sought to adapt the concepts of reliability and validity to make them applicable for qualitative research (e.g. Kirk and Miller 1986; LeCompte and Goetz 1982), while others have argued that there needs to be completely new concepts for them to be applicable (Bryman, 2012). With much research still, in some way, adhering to the concepts of reliability and validity, we argue that these concepts still can provide a basis for discussing the research quality of a qualitative research study. However, Leung (2015) suggests that a more appropriate way of assessing research quality for qualitative studies is by looking at reliability, validity and generalizability. Thus, we choose to proceed with this set of concepts, arguing that it maintains familiarity while being more adapted to qualitative research.

### 3.4.1 Reliability

Reliability involves the accuracy of research methods and techniques used in a study (LeCompte and Goetz, 1982; Bryman, 2012). Further, several researchers distinguish between internal and external reliability (Campbell and Stanley, 1963; LeCompte and Goetz, 1982; Bryman, 2012). Internal reliability deals with to what extent the observers agree about what they see and hear, while external reliability deals with to what extent the study can be replicated with the same result. We argue that we have assured reliability by using several sources of data, looking at data from automotive industry in specific and combining it with theories and data from other industries. We refer to our approach of using several sources of data as triangulation, a term first conceptualized by Webb et al. (1966), who argued that the use of multiple sources of data result in greater confidence in findings.

To get reliable data from interviews, the interview topics were intentionally made to overlap. This has ensured that the data collected was representative for more than one person. During the interviews both writers of this thesis attended, which we argue made the interviews more free from the interpretation of only one person. The questions asked were intended to not lead the interviewees in any specific direction, which we argue is a reliable approach when researching in an exploratory manner.

Ejvegård (2003) writes that giving interviewees the chance to approve information from the interviews is an approach that can lead to less misinterpretation. This approach was adopted to further strengthen the reliability of the thesis.

### 3.4.2 Validity

In qualitative research, Leung (2015) define validity as the appropriateness of the methods, data and tools used. Other researchers (e.g. LeCompte and Goetz, 1982; Bryman, 2012) make a distinction between internal and external validity, however, we will refrain from that distinction, as external validity bears similarity with generalization, covered in the next section. The theoretical framework in this thesis has aimed to collect previous work and theories, and thus we argue that this section can build on the validity of previous work. Further, the theoretical framework has provided guidance for the rest of the data collection and analyses. Our earlier mentioned approach of triangulation has also brought together many different sources of data, which we argue has contributed to the appropriateness of the methods used. This is also line with the reasoning of Ejvegård (2003), that the use of different methods is appropriate when studying something with little direct evidence for an analysis or a conclusion.

### 3.4.3 Generalization

When judging qualitative research, generalizability is usually not expected, due to much qualitative research aiming to study a specific issue. However, Leung (2015) argues that generalizability is becoming more important. He also argues that the use of triangulation and comparisons are important in ensuring that the work of a study is achieving generalizability. Though the bulk of the primary data in this thesis derives from NEVS, we argue that the findings are generalizable since NEVS are in a situation similar to that of many other vehicle manufacturers. Many automotive OEMs are faced with opportunities and challenges of big data and are uncertain in how value can be both created and appropriated from it. As previously argued, the case study of NEVS is also complemented with other sources of data before making any analyses. Thus, this thesis is argued to provide insights about the whole automotive industry.

The comparative cases aim to outline phenomenons that are generalizable for other industries. With Enkel, Gassmann and Chesbrough (2009) claiming that the growth of internet technology is making companies in other industries become increasingly important sources of innovation, we argue that these phenomenons provide a generalizable collection of data. In addition, we do not intend for these cases to provide definitive answers or solutions, but merely uncover insights that may not yet have been uncovered within the automotive industry. For the chapter of analysis, the comparative cases therefore enable a discussion of differences and similarities between the automotive industry and other industries.

### 3.4.4 Critique of the Research Methodology

Bryman (2012) notes that a multi-case study, such as ours, put researchers in a better position to both question and suggest theory. However, he also argues that one disadvantage of the comparative design is that it can neglect the contexts of the different findings. This is a valid critique that applies to this thesis, though as argued before, we do not intend for the comparative cases to provide definitive answers or solutions, knowing that they are all unique cases with different contexts. We further argue that the way in which the cases have been analyzed and discussed showcases that consideration to different contexts has been made.

One could argue that we should have collected data from more primary sources to outline the comparative cases in this thesis. Though e.g. interviewees with individuals from concerned organizations would have provided us with more knowledge and arguably more extensive findings, it is outside of the scope of this thesis (due to both cost and time constraints). It is therefore left to future researchers to explore these cases more in-depth. Despite this, we argue that the comparative cases provide us with enough material to gain new insights about the value creation and appropriation of vehicle data.

# 4 Data in the Automotive Industry

In this chapter, the empirical findings from interviews and review of industry reports on the topic of vehicle data and how to create value from it are presented. The first section treats the technical and legal aspects of collecting and using vehicle data. The second section identifies potential use cases for data, whom value can be created for, and how this value can be created. In the third section findings important for how value can be appropriated by automotive OEMs are presented.

## 4.1 Collecting Data

This section treats the technical and legal aspects of collecting data, with a division of the two aspects in two subsections. The subsection treating technical aspects is based on interviews with the technical expert (Interview 1), Car Connectivity Manager at NEVS, and with the product development expert (Interview 4), Attribute Performance Manager at NEVS. The subsection about legal aspects is based on an interview with the legal expert (Interview 2), Business Development Manager at NEVS, several first hand sources from authorities and organizations, and some analyses from legal experts.

### 4.1.1 Technical Aspects

The electrical systems in a modern vehicle is controlled by a number of so-called Electrical Control Units (ECU) (Interview 1). There can e.g. be an ECU controlling the systems in the engine, another controlling the systems in a door, another one for the suspension system etc. Each of these ECUs controls a number of sensors that send the ECU data about something, e.g. a door opening and closing or the amount of oxygen in the engine cylinders that lets the engine ECU decide whether the air-fuel ratio needs to be changed. These kinds of sensors overseeing technical things in the different components of the vehicle produces around 400 different signals with dynamic values, generating about 750 MB of data per vehicle per day.

A second type of data that a vehicle generates comes from sensors picking up environment parameters, i.e. things that happen outside of the vehicle itself (Interview 1). This could e.g. be sensors deciding what the temperature and weather is like, cameras or radars generating data about pedestrians, other vehicles and other things around the car, or data about the driver and the passengers. Connectivity with other vehicles also lets vehicles share data between one another. A third type of data can be fed to the vehicle through its connectivity to a cloud solution, meaning that data from third-parties can be integrated with the data that the vehicle itself produces. Examples of third-party data that is fed to a car are weather data, traffic data, or music. Table 2 summarizes and exemplifies what kinds of data that are present in a connected vehicle.

| Data type | Examples of data points |
|---|---|
| *Technical data* | Doors opening and closing |
| | Air-fuel ratio |
| | GPS location |
| | Battery charge |
| | Speed |
| *Environmental data* | Air temperature |
| | Precipitation |
| | Other cars |
| | Who is the driver |
| | Camera data |
| *Third-party data* | Streaming music |
| | Weather data |
| | Traffic data |
| | Social media |
| | Other types of infotainment |

*Table 2. Displaying some of the different data points within the different data types identified by Interviewee 1.*

For data to actually say something, analysis have to be done by the ECUs in the vehicle or by computers outside of the vehicle. About 20-25% of computations that NEVS' vehicles make are made within the vehicle itself, and the rest of the computations are made outside of the car, through cross-computations between different cloud environments (Interview 1). Some of the data analyses must be done externally, due to the demand for computing capacity. In contrast, some data analyses can not be done outside the vehicle, due to the delay that occurs when sending data outside of the car, analyzing it there and then sending it back to the vehicle. Today, NEVS only stores technical data generated by the car itself and do so in data containers external to the car. Data is saved due to the belief that there are future applications of the data that are not discovered yet.

In NEVS' view there are barely any technical limitations at all to what data that can be collected in a vehicle (Interviews 1, 4). A sensor generating data can be put anywhere. The hard part is instead knowing what to do with the large quantities of data. For data to become of value a pattern needs to be found, which can cost a lot in terms of time spent. In addition, the more complex analyses that have to be made through e.g. cross-analyzing data, the more cloud-environments will charge, since their pricing models are based upon charging for data transactions rather than static data storage.

### 4.1.2 Legal Aspects

What can and can not be done with data in Europe is first and foremost regulated in privacy laws and in special cases laws regarding national security (Interview 2). The GDPR, implemented in May 2018, which is intended to secure the personal integrity of EU citizens, is the main piece of regulation that companies have to adhere to when it comes to data issues. Under the GDPR, data subjects (individuals) must give clear and distinguishable consent to their personal data being collected and processed, and it must be as easy to withdraw this consent (EU GDPR Information Portal, 2018). The data subject will also have the right to obtain confirmation from the data controller whether personal data concerning them is being processed and be provided with a copy of the personal data, free of charge. Included in the regulations is also the right to be forgotten, meaning that the data subject is entitled to have the data controller erase his/her personal data, cease further dissemination of the data, and have third parties stop processing the data. The fines for non-compliance can amount to as much as 4% of annual global turnover. All in all, the GDPR is intended to strengthen the rights of consumers, or data subjects, and forces data controllers to be more transparent with what data they collect and what they are going to use it for.

The European auto manufacturers main lobby group, the ACEA, has adopted five principles of data protection (ACEA, n.d.), which show what they commit to in order to comply with the GDPR. These principles are: taking data protection into account at all times, being transparent, giving customers choice, maintaining data security, and processing personal data in a proportionate manner. The principles, with formulations such as “proportionate manner”, are not very well-defined, leaving manufacturers with quite a bit of leeway. Further, manufacturers commit to only share personal data with third parties on the basis of a contract with the customer, or with the consent of the customer, or to comply with legal obligations (ACEA, 2018).

All data is however not personal data and is therefore not subject to regulation under the GDPR (Interview 2). For vehicle data that can not be tied to an individual, much broader contractual arrangements can be made with the owner of the car. The GDPR could however still bring some difficulties since anonymous vehicle data could become non-anonymous when combined with other data. The legal expert (Interview 2) points out that an example would be combining GPS data from the vehicle, showing where it has been, how far it has driven etc., with data about who the driver is based on whose personal ID was used to start the engine. Making sure that data stays anonymous is therefore vital to not get in trouble with the GDPR. In projects that NEVS is participating in, IBM has made it clear that they will not let non-anonymous data from vehicles enter their servers whatsoever (Interview 2). To comply with this, companies may choose different solutions to make sure that data stays anonymous. One method that can be used is to add a random variable to the data gathered from each individual vehicle, making it worthless to look at data from individual vehicles, but that evens out when looking at statistical data from the whole fleet of vehicles. The legal expert (Interview 2) highlights this as an innovative way of maintaining privacy for the customer while still providing high quality data from the fleet. In his view it is usually the patterns of the aggregated data from whole fleets of vehicles that is interesting and valuable, rather than personal data on individuals.

In NEVS' other focal market, China, a new cyber security law was implemented on June 1, 2017 that codified data privacy obligations, such as the adoption of security measures and notification and consent requirements (Bird, n.d.). Also, rules for transmitting personal information and important data outside of China became stricter. In some important areas, e.g. security testing and procedures for those who process personal information, the Chinese regulations go even further than the European ones. Even though such national security issues play a more important role than privacy for individuals in China, the legal expert at NEVS (Interview 2) believes that the situation for the vehicle manufacturer is similar since there is still somebody that must be asked for permission. The Chinese regulations state that data about Chinese citizens and cities has to be handled within China and can not leave Chinese servers. While this may bring challenges, the opportunities for gathering data about and mapping usage patterns of Chinese citizens are big (Interview 2). Despite the differences, the recent updates to Chinese and European regulations represent a convergence of the rules between the two markets (Sacks, 2018)

Whereas the EU and China are taking steps to strengthen and formalize privacy regulations, such steps have not yet been taken in the United States (Sacks, 2018). The U.S. does not have an extensive data privacy policy and no uniform concept of user data ownership or consent, in effect letting the EU set the playing field of global privacy as American firms have to follow along in order to not lose access to the European market (Hart & Fischer, 2017). Just like European ACEA, the American automotive trade associations, the Alliance of Automobile Manufacturers and Global Automakers, have published a set of privacy protection principles of their own. These principles do not however go quite as far as the European regulation demands (Parker et al., 2017).

With regulations demanding that customers give their consent to whatever data that can be recorded and analyzed, law firm Allen & Overy (Parker et al., 2017) describe the public's willingness to share their personal data as one of the biggest legal issues facing the connected vehicle market. A McKinsey (2016a) survey however showed that this willingness seems to be higher than had previously been expected and McKinsey conclude that data privacy concerns will probably not be as important as many had previously expected.

## 4.2 Creating Value from Data

This section is primarily based on interviews with people from NEVS and various other organizations and industry reports performed by consultancy firms such as McKinsey, Frost & Sullivan, and Strategy&. In these interviews and reports, efforts are made to identify ways to create value from connected vehicle data. In the following subsections these ways are accounted for and described.

### 4.2.1 Using Data Internally

Consulting firm Strategy& (Viereckl et al., 2016) claim that use of connected vehicle data to increase internal efficiency, quality and product differentiation has among the highest short-term cash flow potential. At NEVS, the only user of collected data today is the company itself (Interview 1). Through own analyses NEVS have the possibility of calibrating their own vehicles and redesigning them according to what insights that the data give them about the vehicle's performance, which is in line with what both McKinsey (2016b) and Frost & Sullivan (2017) recognize when mentioning optimization of R&D and design as one of the ways of using data from cars internally. The product development expert (Interview 4) states that with connected vehicles, NEVS can have real time data or immediate history of data on the vehicle, helping to refine and optimize a vehicle more suitable for its purpose. NEVS is targeting ride-sharing companies and data enables them to create a vehicle optimized for this purpose. One example is that data can help show NEVS which interval of speeds that the vehicles are normally being driven at. If NEVS were to design a vehicle especially suited for driving in densely urban populated areas, data could help them see e.g. if there is a possibility for them to downsize the propulsion system and instead maximize the range that is possible to get from the battery.

In addition to how data can help in product development, NEVS also use data to make "smarter" decisions about when to replace wear components in the car, making possible replacements when needed instead of on regular service intervals (Interview 1). Further, data can help improve vehicle health through driving statistics, self-diagnosis, remote diagnosis, and real-time vehicle information. These are things that become even more important when moving to a business model where the OEM is the owner of the vehicle. This is what both McKinsey (2016b) and Frost & Sullivan (2017) refer to as predictive maintenance, that also could also be sold as a service to an external user and/or owner of the vehicle.

Both McKinsey (2016b) and Frost & Sullivan (2017) identify possibilities of reduction of warranty costs, and early recall detection and software updates. With vehicles becoming increasingly technologically complex, there is a trend towards more vehicle recalls, causing huge costs for OEMs (Steinkamp and Levine, 2017). In 2016, the amount of recalled vehicles in the U.S. alone topped 50 million. These recalls cost OEMs and suppliers a total of 22.1 billion USD in claims and warranty accruals (Jibrell, 2018). The earlier a faulty component can be detected, preferably before it has even caused a serious problem, the better recalls can be prevented, predicted or minimised. Continuous monitoring and analysis of data and finding patterns for which components that may cause problems, can achieve this. In cases where problems are software related, possibilities for over-the-air software updates reduce the need for recalls as problems can be fixed without the need for recalling the vehicle at all.

Apart from data collected on their own, NEVS also receives data about how vehicles are used from their partner DiDi (a Chinese mobility services company). The data that DiDi collects could tell NEVS specifically what the mobility needs are of the consumers, helping them in optimization (Interview 4). DiDi's experience with having a fleet for several years is a valuable addition to NEVS's own pool of data. A specific example of how data from DiDi could help NEVS, is how the DiDi app could make it possible for customers to give information in their bookings about how many passengers they are, amount of luggage and maybe more parameters. This data is something NEVS could not collect inside the car without having to build very sophisticated sensors. Information like this can be used to complement the data that NEVS can collect themselves. Already today data from DiDi about which side most customers open the door on is provided and can help NEVS in optimizing their cars for DiDi's usage (Interview 3).

Another example of internal use of data comes from Tesla, that have put themselves in a strong position in the automotive industry, involving a strategic use of big data and artificial intelligence. In October of 2014 Tesla offered customers who bought a new vehicle an optional package that included cameras and sensors, which helped to warn the driver about collisions before they happened (Ahdoot, 2016). After a year of collecting data, the owners of these packages received an over-the-air (OTA) software update which gave their vehicles self-driving capabilities which has later been incrementally improved by more OTA updates. Tesla's advanced sensors and autopilot software have made it possible for them to collect lots of new data and to generate road maps for driverless cars, which includes information about e.g. where cars have slowed down for traffic and where cars have swerved around less visible obstacles that have appeared. The entire fleet of Tesla vehicles is educated by machine learning in the cloud, while edge computing in each individual vehicle lets it decide what action to take in each moment (Marr, 2018). Through unsupervised machine learning models, Teslas learn how to operate in traffic by simply observing human drivers. Marr (2018) argues that it is their long-term strategy to gather lots of data that has enabled Tesla to become one of the leaders in the development of autonomous vehicles. Table 3 summarizes the use cases identified in this section.

| Use case | Source |
|---|---|
| Optimizing R&D and design | Interviews 1 and 2, McKinsey (2016), Frost & Sullivan (2017) |
| Predictive maintenance | Interview 1, McKinsey (2016), Frost & Sullivan (2017) |
| Reduction of warranty costs | McKinsey (2016), Frost & Sullivan (2017) |
| Early recall detection and software updates | McKinsey (2016), Frost & Sullivan (2017) |
| Accommodate development of Artificial Intelligence | Marr (2018) |

*Table 3. A summary of the use cases identified in this section.*

### 4.2.2 Offering Services for the Vehicle User or Owner

Focusing on services is a growing concern for OEMs in the automotive industry (Interview 5). Care by Volvo, a new subscription-based service that lets customers pay a monthly subscription fee in exchange for a package of services, is an example of how actors in the automotive industry are trying to offer vehicles in the form of a service. Packages of services like these can include insurances, maintenance and the option of changing car more often than people have done before. The data researcher (Interview 5) thinks that seeing the vehicle as a platform of digital services is important, since it will make automotive OEMs able to continuously update the list of services available from the vehicle.

In their identifications of use cases, both McKinsey (2016b) and Frost & Sullivan (2017) highlight usage-based insurance. With data about a driver's driving behavior, individuals could pay a customized insurance premium (Interview 1). Though this solution is not implemented at NEVS yet, there is already today companies working with offering customers this product, which will make use of data that NEVS has from the driver. Implementing data collection methods and analyses for offering customers customized insurance premiums can be done by NEVS themselves and would not demand data from any more party, though insurance companies would need to be collaborated with. In addition to usage-based insurance, McKinsey and Frost & Sullivan (2017) also mention usage-based tolling and tax as a possible use case, which would let vehicle owners pay taxes and tolls based on how much they are driving instead of paying a fixed fee.

NEVS sees possibilities to improve navigation systems by letting the driver get information about so called points of interest (specific locations that might be useful or interesting), real time traffic information, and recommendations of parking and charging locations (Interview 1). McKinsey (2016b) also identify the possibility of parking recommendations, terming it "networked parking service". On the note of navigation services, NEVS also sees the possible use of environment data from vehicles for providing information to other vehicles in a fleet (Interview 1). If one vehicle gets stuck in a traffic jam, other vehicles that are behind can get to know about this and in effect get a better route recommendation. Both McKinsey (2016b) and Frost & Sullivan (2017) also highlight connected navigation services among the use cases for vehicle data.

Safety and security is another area in where vehicle data can be useful. In cases of emergency, NEVS has the ability to remotely control their own vehicles, which can help them assist authorities when needed (Interview 1). In addition, car-to-car data can enable vehicle manufacturers to develop safety package services that assist the driver in avoiding crashes in traffic (Interview 5). Further, driver's condition monitoring services can help drivers stay alert, thus lowering risks of accidents (McKinsey, 2016b). Emergency call service, such as the European eCall system, can automatically call emergency services in the case of an accident which reduces emergency response times. On a similar note, McKinsey (2016b) also suggest breakdown call services. Stolen vehicle tracking and theft protection help keep vehicles safe from theft (McKinsey, 2016b; Frost & Sullivan, 2017) and with geofencing, OEMs or vehicle owners can e.g. define in what geographical areas a vehicle is allowed to be and alert the driver or owner if the vehicle leaves the area (Interview 1; Frost & Sullivan, 2017)

With increasing degrees of autonomy, data-enabled services making mobility fun will become more important (McKinsey, 2016b). Within this space McKinsey (2016b) sums up opportunities to create social and interactive experiences such as augmented reality games between different drivers and passengers in different vehicles as "gamified"/social-like driving experience. On the note of entertainment, NEVS also recognize infotainment with e.g. online music as an important way of using data (Interview 1). Further, data enables e-commerce solutions with recommendations, browsing, purchases, and even delivery of non-driving related goods to the car (Interview 5; McKinsey, 2016b; Frost & Sullivan, 2017). With the vehicle as a commercial platform targeted advertisements and promotions also become more viable (McKinsey, 2016b).

With a focus on serving companies with fleets of vehicles, fleet management services for vehicle fleet owners will also be important (Interview 1). Remote car performance configuration is a use case that makes it possible to remotely tune the vehicle to better fit the needs of the owner, in terms of e.g. fuel economy and power (McKinsey, 2016b), and software-over-the-air (SOTA) and firmware-over-the-air (FOTA) makes it possible to remotely upgrade the vehicle's software and firmware (Interview 1). McKinsey (2016b) further suggest that vehicle usage monitoring and scoring can provide vehicle owners and used-vehicle buyers with much more accurate information about the history and condition of the vehicle, enabling more accurate valuation and quality certification of used vehicles. NEVS also recognize user systems that can display traffic violations and other user-specific data (Interview 1).

With the increasing availability of software apps and data-enabled services in vehicles, software-hardware integrating platforms and operating systems (OS) become more important, and multiple high-tech giants are already entering the field and are initiating partnerships with automotive OEMs (McKinsey, 2016b). With Google's Android Auto app and Apple's CarPlay app it is possible to mirror features from Android or iOS devices to the head unit of a connected vehicle that supports those apps (Android, n.d; Apple, n.d). In 2017 Google announced partnerships with Audi and Volvo to let their new models run on Android as a fully integrated operating system that doesn't require a handheld device (O'Kane, 2017). In May 2018, Volvo and Google showcased a Volvo XC40 prototype with the integrated Android Auto, expected to be released to consumers in 2020 Volvo models (Garun, 2018). Among other things, the integrated Android Auto supports the voice-activated Google Assistant that can help the driver to e.g. play music, look up directions, adjust the cabin temperature, and book a maintenance appointment based on predictive maintenance. The integrated Android OS also supports Google Play that lets the user buy approved third-party apps. Also Apple, Samsung, BlackBerry and Microsoft are contestants within the connected vehicle OS field (Everett, 2016). Tesla, often deemed a pioneer in connectivity features, has instead of partnering up with a tech giant chosen to develop its own operating system. Table 4 summarizes the use cases identified in this section.

| Use case | Source |
|---|---|
| Usage-based insurance | Interview 1, McKinsey (2016), Frost & Sullivan (2017) |
| Usage-based tolling and tax | McKinsey (2016), Frost & Sullivan (2017) |
| Connected navigation services | Interview 1, McKinsey (2016), Frost & Sullivan (2017) |
| Remotely controlling vehicles | Interview 1 |
| Driver’s condition monitoring service | McKinsey (2016) |
| Emergency call service | McKinsey (2016) |
| Breakdown call service | McKinsey (2016) |
| Stolen vehicle tracking and theft protection | McKinsey (2016). Frost & Sullivan (2017) |
| Geofencing | Interview 1, Frost & Sullivan (2017) |
| “Gamified”/social-like driving experience | McKinsey (2016) |
| Infotainment with e.g. online music | Interview 1 |
| E-commerce | Interview 5, McKinsey (2016). Frost & Sullivan (2017) |
| Targeted advertisements and promotions | McKinsey (2016) |
| Fleet management services | Interview 1 |
| Remote car performance configuration | McKinsey (2016) |
| SOTA and FOTA | Interview 1 |
| Vehicle usage monitoring and scoring | Interview 1, McKinsey (2016) |

*Table 4. A summary of the use cases identified in this section.*

### 4.2.3 Offering Services for Others

There are also cases where vehicle data can become valuable for external stakeholders, i.e. not the OEM itself, nor the vehicle user or owner. For example, mobility data collected from vehicles in a whole city has the potential to help improve traffic systems and avoid congestions in traffic (Interview 5). There is also a lot to be gained for city-planners, the environment, and car-sharing businesses if use of cars can become more efficient. Similarly, McKinsey (2016b) and Frost & Sullivan (2017) suggest improving road infrastructure as a viable use case. In addition, McKinsey

(2016b) suggest aggregated car data-based CCTV service, and road laws monitoring and enforcement. On the note of safety and security, Frost & Sullivan (2017) also suggest that vehicle data can be used to optimize emergency assistance providers services. Being able to retrieve continuous data about the weather conditions in different regions and information about the road conditions, the technical expert (Interview 1) envisions that NEVS' data could be of value to companies whose business models revolve around these elements.

A portfolio manager who works with science and innovation at Trafikverket (Interview 7), a Swedish government agency working within transportation, expressed interest in collaborating with automotive OEMs to get data about road and weather conditions that could help them make timely adjustments to the road. Trafikverket is already engaging in collaborative research to explore how data from vehicles can help them in their work. In the long term, vehicle data of e.g. road friction, air temperature, fog conditions, amount of rain, can replace the data that Trafikverket today collect themselves. In the short term, the new stream of data can complement their own data. According to a traffic analyst at Trafikkontoret Stockholm (Interview 10), so called floating car data is used for getting travel time data, from e.g. a system that TomTom have installed in taxi cars. However, with more cars the analyses would become better. Data from bigger numbers of connected vehicles could help create value in areas such as optimizing route recommendations and could potentially replace more traditional ways of gathering traffic data.

An urban planning manager at Trafikkontoret in Gothenburg (Interview 11) expresses that data could help them in three areas. First, data about traffic patterns can help them in long-range infrastructure planning and give them improved possibilities to model the effects of e.g. accidents and changes. Today floating car data is bought with information about e.g. positions and speeds, but one problem is that there are too few floating cars. Data from more cars would help make better analyses. Secondly, data could help to improve their work with maintenance and services of roads (e.g. repairing damages and asphalt). Today's way of working is both time and resource consuming, why getting more information about where maintenance and services is needed can lead to more efficient work. Lastly, Trafikkontoret would benefit from getting real time data of travel times between different points to make better recommendations of alternative routes to road users, helping traffic flow better. Today cameras are used to identify cars in different parts of the city and calculate their travel times between certain points. Real time data from connected vehicles would give more reliable and complete information.

A climatologist at SMHI (Sweden's meteorological and hydrological institute) (Interview 9), state that weather information from cars could help provide more measurement points of precipitation. Today they do not have as much data as they would like to perform research on local weather phenomena, so data from a fleet of connected vehicles could help inform SMHI of e.g. local downpours. For forecasting the weather, however, there does not have to be as tight a grid of measurement points to provide what SMHI finds is enough information. In e.g. Europe and North America the data collection that they have today is already enough, therefore data would have to be from e.g. Africa to help them in a new way. To buy data from someone else the climatologist (Interview 9) thinks they would need to both verify and clear the data from sources of error. For this reason, he does not think that SMHI would like to pay very much for the data. Table 5 summarizes the use cases identified in this section.

| Use case | Source |
|---|---|
| Improving road infrastructure | Interviews 1, 5, 7, 10, 11, McKinsey (2016), Frost & Sullivan (2017) |
| Aggregated car data-based CCTV service | McKinsey (2016) |
| Road laws monitoring and enforcement | McKinsey (2016) |
| Optimize emergency assistance providers services | Frost & Sullivan (2017) |
| Improve weather forecasts | Interviews 1, 9 |

*Table 5. A summary of the use cases identified in this section.*

### 4.2.4 Making Data Valuable

To create value from data, the data first has to be representative of the population that you want to look at (Interview 4, 11). Having collected data from a bus fleet the portfolio manager (Interview 7) says that Trafikverket has realized that they do not need the data from many vehicles to get what they think is representative data. In contrast, the traffic analyst (Interview 10), states that for Trafikkontoret to buy data from automotive OEMs there needs to be more vehicles collecting data, which would make data more representative for the whole city. In addition, there must be both good accessibility and cheap access of the data. The manager at Trafikkontoret (Interview 8) also highlights that data needs to be well-structured, well-documented, and verified. In addition, scale seems to be a prerequisite to create most services and products from data (Interview 5). With data from vehicles in a whole city there are more interesting insights to be gained than from single cars.

The next step after collecting data, of understanding it, requires people capable of thinking outside the box and identifying trends, which involves looking at e.g. geographical and demographical patterns and cross-analyzing these (Interview 4). According to the technical expert (Interview 1) it is hard for an automotive manufacturer to find new areas of application for data themselves. The process can be complex and includes finding patterns for how data should be analyzed and finding out if more sources of data is needed to make analyses, and if so getting hold of that data. Seeing the vehicle as a platform for digital services, the data researcher (Interview 5) argues that automotive OEMs are faced with many new business opportunities that they have little experience with, making it essential to collaborate with others. One useful way of collaborating is open innovation.

When talking about how data can help NEVS internal processes the product development expert (Interview 4) stretches the importance of having close relationships with other companies in the value chain. In creating mobility services, NEVS is only part of this value chain. NEVS has the capabilities of recording and measuring data, but do not believe that analytics is something that they would do best themselves. Within mobility there are also other intermediate steps that involve competencies that NEVS do not possess and therefore make it essential for them to partner up with other firms. Generally, the product development expert (Interview 4) argues, automotive OEMs have a lot of inherited inertia within the organizational structures. To deal with this, NEVS is adopting a new organizational structure that should encourage more fluidity within their organization.

Potentially, the data collected by NEVS could help a lot of other actors, but NEVS have yet to recognize which actors and in which ways (Interview 3). For this reason, collaborating and co-creating is seen as useful, and openness and transparency with data are further seen as useful tools to connect with actors outside the company and thus gain insights and new knowledge from other disciplines. The data researcher (Interview 5) argues that vehicle manufacturers should try to build an ecosystem for offering data-enabled services. To do this OEMs need to be more open to collaborating with others, e.g. due to lacking experience in drawing value from data. Accenture Strategy (Gissler, 2015) agree with mentioned interviewees (Interview 3, 5) that openness is important, and outline a basic model for how an open technology system can facilitate a connectivity ecosystem where standardized APIs enable seamless integration of third-party apps and services, and big data and analytics are vital to creating data-driven services.

The portfolio manager (Interview 7) claims that there are obstacles to overcome before Trafikverket can buy car data. Internally Trafikverket's own regulations must change for them to be able to buy data in a more agile fashion. Further, actors that provide data need to be able to demonstrate the possibilities with the data, though this is something Trafikverket would be willing to collaborate to do. There also needs to be a business model that ensures the integrity of vehicle users before Trafikverket are interested in taking on data from vehicle manufacturers. The portfolio manager (Interview 7) makes clear that they are more interested in buying services providing actionable insights in the future, than receiving raw data for themself to analyze. In addition, they think it would be wise to collaborate closely with academics to make sure they are kept up to date with new knowledge. The climatologist (Interview 9) thinks a good approach would be to create a platform together with OEMs where data is gathered. Such a platform would display data possibilities and be able to show which customers' of SMHI that would be interested in the data. In line with this, the urban planning manager (Interview 11) also highlights good accessibility to data as an important part in making data useful.

## 4.3 Capturing Value from Data

According to the IP expert (Interview 6), the value of any intellectual property is in the end connected with to what extent it can contribute to positively influencing the customer's willingness to buy what the IP owner sells. In his view, appropriation of the value of data for vehicle manufacturers thus follows from the fact that customers choose to buy one manufacturer's vehicle over another's, which can be translated into increased market share or increased price. Internally, the IP expert (Interview 6) therefore believes that the value of data can be appropriated by improving the products, resulting in higher revenue, or by creating cost-advantages in the production of the vehicles. In addition, access to data that can be valuable to suppliers can provide leverage in negotiations over prices of components etc., which can also result in decreased costs.

McKinsey (2016b) identify a few different pricing models for companies to capture the created value from data-enabled services, depending on attitudes and needs of local customers. A few examples of possible pricing models for data-enabled products/services are: rolled into vehicle or mobility service price; one-off payment after the initial vehicle purchase, often via an aftermarket channel; paid regularly as a subscription, such as an annual fee for navigation map updates; deducted/debited from a rechargeable credit; covered by tailored advertising pushed to the end customers; or elaborating, analyzing, and reselling data generated by the services.

In a report from 2017, British law firm Allen & Overy (Parker et al., 2017) identifies "increased complexity in questions regarding ownership of IP as collaborations and partnerships become more frequent" as one of the biggest legal issues facing the connected and autonomous car market. To handle this complexity, they recommend companies to clearly agree on which party in a collaboration that will have the rights to exploit jointly developed IP. They also suggest that strong defence of IPRs, e.g. by using trade secrets, may not be the best solution, since companies may be able to profit from a more collaborative approach that speeds up market adoption by opening up innovation to the market.

As vehicles become increasingly intelligent, the IP expert (Interview 6) believes that there are certain areas in where access to the right data is key to establish competitive advantage, and that data therefore can prove to be an even more important asset than technical patents. The legal expert (Interview 2) believes that as data becomes a more important part of the business of vehicle manufacturers and partnerships between multiple companies become more prevalent, contractual arrangements between the companies will be highly important in deciding who gets to appropriate the value created by the data. Facebook has become successful by gaining personal data from its users for free, but that free access to data from partners will most likely not be the case for companies in the automotive industry, where partners are big industrial companies instead of individuals.

When it comes to sharing data with third-parties, the IP expert (Interview 6) stresses that there are important differences between making transactions with data and other forms of IP, e.g. patents. While legal protection might be stronger for patents, making certain transactions easier, a patent only represents a right to use a specific solution to a technical problem, not the solution itself. Many times, merely transferring a patent is not enough; also a lot of know-how has to be transferred for the patent to be valuable for the new holder, making the transaction much more complicated. In the case of e.g. licensing out access to a database, on the other hand, the data itself is what is important and is included in the transaction. In effect, in many cases it can be easier to create openness and exchange with data than with patents, since it is much easier to control who gets access to what, at what times etc., by employing software solutions in the case of data than in the case of patents. Even though legal protection around patents is stronger than around databases, the IP expert (Interview 6) does not believe that a data controller necessarily is in a weaker position of control than a patent holder. Whereas a patent becomes public and many times can be invented around, certain data can require a huge amount of effort and time to gather, as in cases where sheer number of driven kilometers is important.

# 5 Comparative Cases

Enkel, Gassmann and Chesbrough (2009) claim that with the development of internet technology, companies in other industries become increasingly important sources of innovation:

> *Established solutions from other industries will enrich corporate product development while reducing the related risks through reducing uncertainty. The corporate silos in R&D and innovation functions will be more open to external leverages. (p. 314)*

This suggests that automotive OEMs might have a lot to learn from looking at examples of how data has been handled in other industries. In fact, most companies have struggled to appropriate anything more than modest gains from their investments in big data, advanced analytics, and machine learning, with Google, Facebook and Netflix being a few of the exceptions (Henke, Libarikian & Wiseman, 2016). With this in mind, we will in this chapter describe a range of comparative cases intended to highlight how companies in other industries have created and appropriated value from data, and also to reveal potential pitfalls.

## 5.1 How Google and Facebook Use Data to Improve Advertising

Over the last decades, the advertising industry has changed dramatically with companies increasingly shifting their advertising budgets away from traditional media toward online ads (Richter, 2017). The online advertising industry is today completely dominated by Google and Facebook, that 2017 together accounted for more than 60 percent of global online advertising revenues and 25 percent of total media advertising revenues. However, neither of these companies started out as advertising companies. Google started out as a search engine and Facebook as a social media platform, both without business models that would allow them to generate income (Marr, 2016).

In the early days, Google's focus was to bring all the information on the internet together to make it easier for users to find things. With the widespread information uploaded to the internet, Google helped to match search queries with potentially useful results. Since then Google have monetized their search engine by working out a way to use the data it collects, becoming the biggest seller of online advertising in the world. For each user that use the different Google products (Google search, Youtube, etc.), more data can be collected to improve their own products. Google's main source of revenue is its business delivering relevant and cost-effective online advertising, Google AdWords (McFarlane, 2012). Paying companies are given the possibility to get advertising connected to a specific search term, meaning that users find the paying companies' websites more easily through these search terms. According to McFarlane (2012) Google thus provides a way of advertising that targets potential clientele very accurately. Advertisements on AdWords normally have a cost per click basis, meaning that advertisers are paying based on the number of clicks made.

Compared with advertising on traditional media (e.g. radio, television and newspapers) Google is able to draw a distinction between people who are actively in the market for whatever product that the advertising company is selling and people who are passively surfing the web without clicking any further into the advertising company's site (McFarlane, 2012). To let companies stay top-of-mind among these passive surfers, Google also has a model of letting companies pay per impression, meaning they charge a small amount for each person accessing a page on which an ad appears (without continuing to website). Instead of having ads directly on the Google webpage, Google AdSense also allow owners of other websites to include Google-branded ads on their webpages.

Facebook's growth to become the world's leading social media platform has given it access to incredible amounts of data about its users which it has been able to use to take up the fight over the online advertising industry with Google. Facebook Ads advertising offer businesses a way to find specific audiences for their adverts within Facebook's network of users (Shewan, 2017). By tracking their users' behaviors on the Facebook webpage and other Facebook-owned platforms (e.g. Whatsapp, Instagram, etc.), as well as using cookies from other webpages, Facebook can collect large amounts of data on users and their behaviors which can be used to place them in different target groups.

Forouzandeh, Soltanpanah, and Sheikhahmadi (2014) terms the marketing that Facebook offer to businesses content marketing, defined as a way of marketing that focuses on creating and distributing content for a targeted customer. Compared to other types of marketing that are used in social networks, content marketing establishes a sense of trust in users to the content provider. In turn, the trust created raises the revenues of goods sold through the marketing. Fuchs (2012) argues that Facebook has found a way to make their users so called prosumers, meaning that they are both producers and consumers. By collecting data from its users, Facebook has been able to create value in terms of targeted marketing and earn profits without any costs in terms of the production of the data that users provide.

## 5.2 How Netflix Uses Data to Create Better Content

Netflix has moved from being a DVD-by-mail service to launching a streaming media service (Chowdhury, 2017). After launching their streaming media service in 2007 Netflix started collecting data on how their users used the service. A few of the data points that Netflix look at are: when users watch a show, where they watch it, on which device they watch it, when they pause a program and if they re-watch any portion of a program. In 2013 they launched their first original production, "House of Cards", which had been produced based on insights given by big data analytics. Analyzing what kind of stories, what actors, and what directors that groups of users liked to watch, Netflix could put together a combination of these ingredients that ensured that the show would appeal to a large enough crowd to ensure a high likelihood of success. Netflix has in this way been able to do away with the concept of pilot episodes since they already know beforehand the likelihood of success and have been able to increase the success rate of new TV shows to 80% as compared to 30%-40% for traditional TV shows.

According to Smith and Telang (2018) Netflix have created value for both customers and businesses through successful matchmaking, similar to how Amazon successfully matches consumers with physical products based on data about purchases. Through their collected big data Netflix have been able to gain insights, and not only tailor-make content for different parts of their audience, but also guide the right users to the right content through their recommendation system. The creation of unique content has partly been made possible thanks to how the shift from video rental stores to online marketplaces have favored niche titles over blockbusters. Smith and Telang (2018) further points out that one of the biggest benefits consumers get on online marketplaces is increased product variety.

Michel (2014) stresses that Netflix's innovative approach in value capturing is a big contributor to their success. By introducing a subscription-based model, Netflix was able to reap higher revenues than what traditional movie rental businesses had. Smith and Telang (2018) mean that Netflix’s subscription-based model have steered the focus to customers instead of advertisers and thus given them more freedom to create their wide variety of content. According to Michel (2014) Netflix’s revenue model, compared to the film-renting’s, makes personalized recommendations an explicit part of its value proposition. Moving from per-rental price to a subscription fee has made the subscription service the new price carrier.

## 5.3 Platforms in the Smartphone Industry

In digital markets where products are made up of both hardware components and software applications, competition tends to be between different platforms that link the component parts of systems together (Grant, 2016). In the smartphone industry, competition between operating systems, that constitute the link between hardware developers, software developers, and users, have been fierce. In the early days of smartphones, Symbian, jointly owned by Nokia, Sony-Ericsson, and Motorola, was the market leader until Apple launched iPhone in 2007 which led to their proprietary iOS taking over the first place in important markets. While Apple did not let other hardware manufacturers use iOS, they provided a software development environment and a market, the App Store, for third-party software developers to build and sell their apps to iPhone users.

The iOS business model is analyzed by Ladhe et al. (2013) and with the terminology that Osterwalder and Pigneur (2010) use to describe business models, the most important parts of the Apple/iOS business model can be described as follows. The two *customer segments* that are being served are users of iPhones and third-party app developers. The *value proposition* for iPhone users is the possibility for customization through easy access to the millions of apps available in the App Store. For App developers the value proposition is an environment for development of apps and a channel to the millions of iPhone users through the App Store. The *revenue streams* from iPhone users first and foremost derive from selling hardware, which Apple is able to charge premium prices for, partly thanks to the popularity of iOS. The revenue streams from app developers derive from Apple taking 30% of all App sales, while the app developers get the remaining 70%. Table 6 summarizes the iOS business model.

| **Customer Segments** | Users of iPhones | App developers |
|---|---|---|
| **Value Propositions** | Customization through easy access to millions of apps | Development environment and a channel to users via App store |
| **Revenue Streams** | Premium hardware prices | 30% of App Store revenues |

*Table 6: Important parts of the Apple/iOS business model.*

As the attractiveness of the smartphone for users is heavily influenced by the number and quality of apps available, and the attractiveness of the marketplace for developers is dependent on the number of users, network effects lead to both users and developers moving from smaller platforms to the biggest one (Grant, 2016). In order to counter the emerging dominance of Apple in the smartphone market, Google developed open-source operating system Android which offered similar functionality to iOS and was first used in an HTC phone in late 2008. Android was then quickly adopted by other manufacturers and had by 2011 secured the position as global market leader, see Figure 5. Android has since 2014 held at least 80% of the global market share, while all other operating systems than Apple's iOS have virtually disappeared. In important markets such as the U.S. and some Western European countries, iOS however still holds close to half of the market (Statista, 2018a). This results in app revenues between iOS and Android being quite equal (Business Insider, 2017).

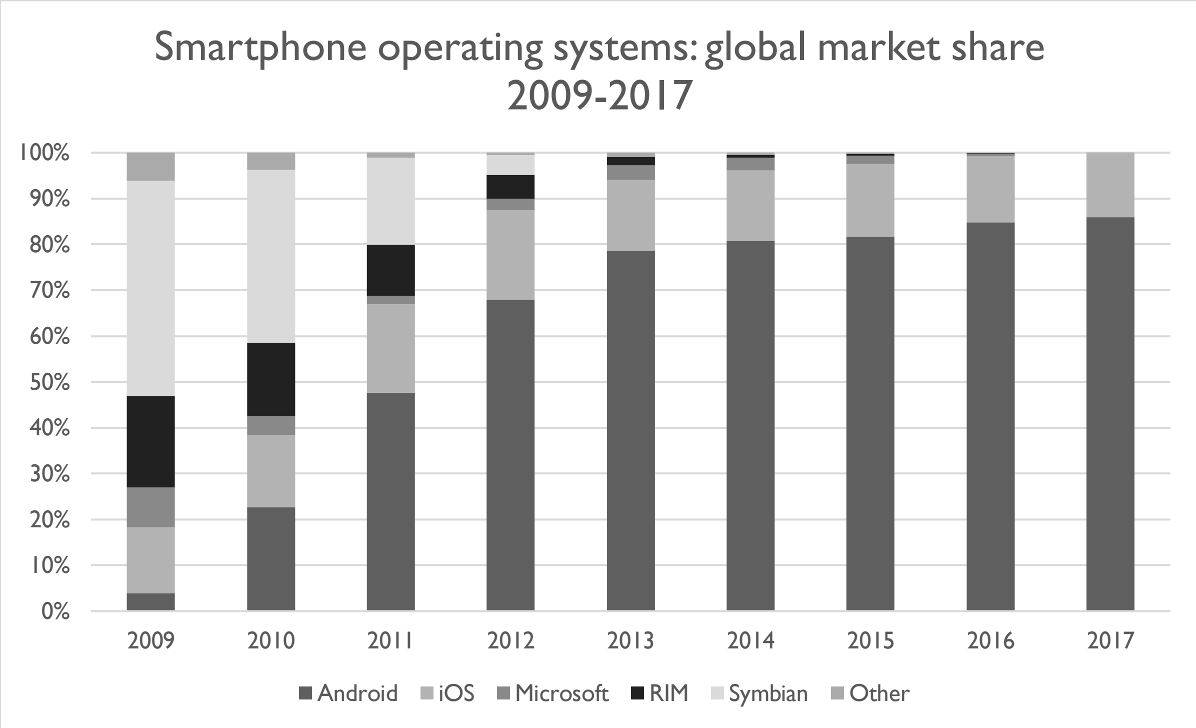


*Figure 5. Global market shares of smartphone operating systems. Data retrieved from Statista (2018b).*

Looking at the market share for manufacturers of smartphones over the same time period, see Figure 6, one can see that a lot has changed as well. Early market leaders Nokia and RIM (producer of the BlackBerry) fell short together with their respective operating systems, Symbian and RIM, while many other brands have entered the field using the Android OS. Looking at both Figure 5 and 6, it is evident that while there are virtually only two smartphone operating systems on the market today, manufacturing of the smartphones themselves is very fragmented, with cut-throat competition and low profit margins for all OEMs except Apple (Grant, 2016). Apple manages to price its hardware at a premium and maintains high profitability much thanks to the popularity of iOS.

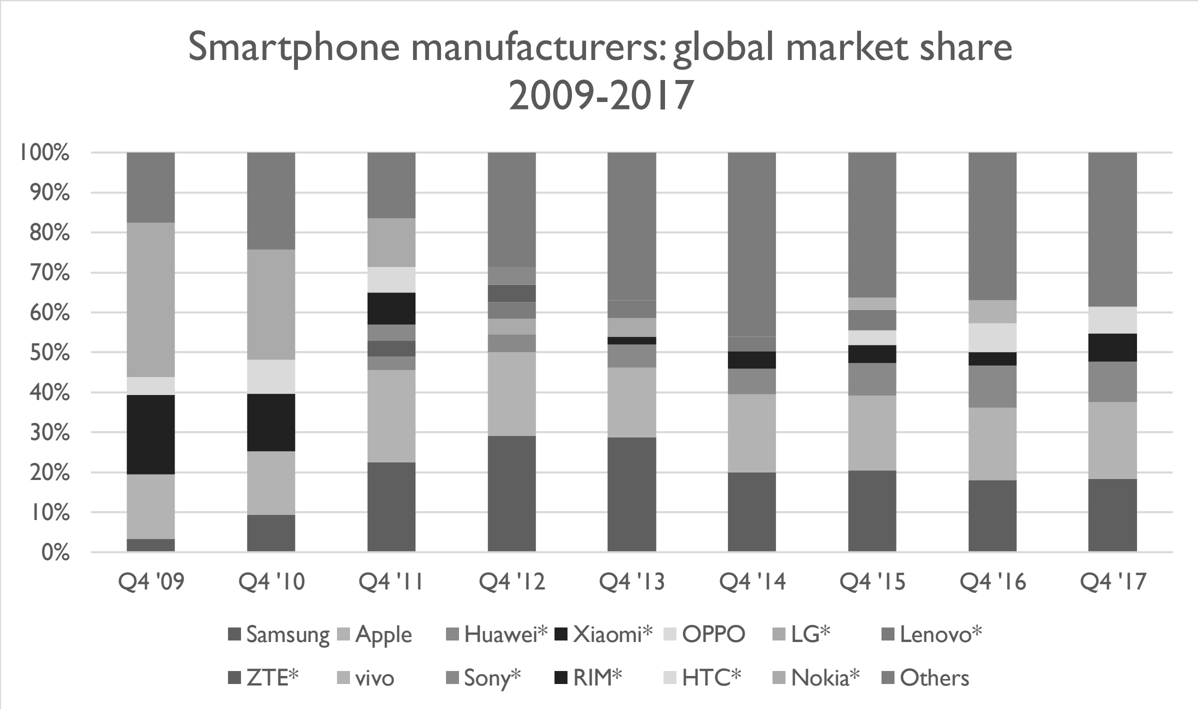


*Figure 6. Global market shares of smartphone manufacturers. Data retrieved from Statista (2018c).*

## 5.4 The Facebook-Cambridge Analytica Scandal

In March 2018, news outlets revealed that political consulting firm Cambridge Analytica had improperly obtained data from 87 million Facebook users, that among other things was used to create psychological profiles of American and British voters which in turn allegedly was used to influence American elections and the Brexit referendum (Confessore, 2018). The scandal immediately sparked outrage among the public and among both American and European lawmakers. A few days after the initial reports on the scandal, Facebook founder and CEO Mark Zuckerberg explained what had happened in a post on his own Facebook page. In the following paragraph Zuckerberg's post is summarized.

In 2007 Facebook enabled users to log into third-party apps and share data about themselves and their friends, in order to make make apps more social (Zuckerberg, 2018). This feature was in 2013 used by Cambridge University researcher Aleksandr Kogan who created a personality quiz app that was installed by around 300,000 people who shared data about themselves and about their friends. This meant that Kogan got access to personal data about tens of millions of Facebook users. In 2015, newspaper The Guardian revealed that Kogan had shared the data that he had obtained from his app with Cambridge Analytica without the consent of the data subjects, something that was against Facebook policy. Facebook demanded Kogan and Cambridge Analytica to delete all improperly acquired data, which they also certified that they had done. With the March 2018 revealing, it became clear that Cambridge Analytica had in fact not deleted the data but continued using it.

The complete fallout of the scandal in terms of e.g. new regulations is still to be seen as this thesis is written, but the implications for the involved companies have so far been serious. In the beginning of May, Cambridge Analytica announced that it would cease most operations and file for bankruptcy, since the scandal had driven away virtually all of its customers (Confessore and Rosenberg, 2018). Facebook received massive critique during the weeks following the scandal and the Facebook stock price fell by 18% over the first ten days (Yahoo Finance, 2018). Johnson (2018) argues that the scandal has the potential to seriously harm Facebook's long-term business as Facebook may now have to limit the extent to which advertisers can direct advertisements to custom audiences, to regain user trust. In the wake of the scandal, the question of data protection regulation has come in focus for lawmakers and Mark Zuckerberg was called to hearings in both the Senate and the House of the U.S. Congress (Confessore, 2018).

## 5.5 How Data is Sold in Other Areas

Across industries, more and more companies commercialize their data by sharing it with others (Belissent, 2017). Data is shared in various forms, from raw data downloads or file transfers, exposing an API to the data for systematic or real-time access, providing an interface to allow self-service data discovery and analysis, or selling an app that enables users to see trends and insights in the data (Woodie, 2017). With new data markets, such as Dawex, DataStreamX, and Quandl popping up and acting as middle-men providing help with provisioning and billing, selling data becomes easier. Selling raw data, however, requires a data- and development-savvy target market which means slower time-to-value than providing insights in a more embedded way.

Navigation company TomTom sell historical traffic data gathered from millions of TomTom navigation devices to external application developers in the form of APIs (TomTom Developer Portal, n.d.). According to market research firm Forrester (Belissent, 2017), data-derived insight services are the most viable way of commercializing data and exemplify with how Siemens Mobility, Boeing and GM offer predictive maintenance services for their trains, planes and cars, and how agricultural products companies Monsanto and DuPont offer services that help farmers decide when to plant, irrigate, apply pesticides and harvest. Legal research firm LexisNexis enable benchmarking that lets clients anticipate the cost of potential litigation depending on firm size, location, matter type, and timekeeper level (LexisNexis, n.d.). Belissent (2017) notices that these services often are first directed towards actors in the vertical vicinity, rather than in unrelated areas.

# 6 Analysis

Wixom and Ross (2017) distinguish between three approaches for companies to appropriate the value of their data, which goes well in line with the empirical findings presented in chapter 4. The first of these approaches is using data to improve internal business processes and decisions. Chapter 4 revealed that for a vehicle manufacturer, this can be done in e.g. the product development process to lower the costs of production and/or create a better vehicle. The second approach is to enrich core products by wrapping them in data, which for a vehicle manufacturer means to create products and services that improve the user's or owner's experience of the vehicle and can lead to sales increases, higher prices and deeper customer loyalty. The third approach is to sell the data itself, and as chapter 4 showed, there are external actors that could benefit from data collected with the help of connected vehicles.

The following analysis of how automotive OEMs can appropriate the value created from vehicle data is structured around the three overarching appropriation approaches. The use cases that were identified in chapter 4 provide examples of how value can be created from vehicle data and are in Table 7 sorted into one of the three appropriation approaches. These use cases have been highlighted as important and with high value potential by interviewees and other sources of information used in the data collection. However, they should not be considered all possible ways in which value can be created from vehicle data, since this is a space where (almost) only imagination sets the boundaries. Table 7 also contains a column that exemplifies which type of vehicle data that is needed for each use case. The analysis in sections 6.1-6.3 focuses on what these use cases requires from OEMs and what factors become important for them to appropriate as much of the value as possible

| Appropriation approach | Value creation Use cases | Data required |
|---|---|---|
| **Improving internal processes** | Optimize R&D/design | Technical data, environmental data (e.g. speed, wear of components, number of passengers) |
| | Reduction of warranty costs | Technical data (e.g. wear on brakes) |
| | Early recall detection and software updates | Technical data (e.g. wear, malfunctions) |
| | Accommodate development of Artificial Intelligence | All possible data (e.g. environmental data on how vehicles behave in traffic) |
| **Enriching the core product** | Usage-based insurance (UBI) | Technical data (e.g. speed etc. witnessing about driving behaviour) |
| | Usage-based tolling and tax | Environmental data (e.g. location) |

| | | |
|---|---|---|
| | Connected navigation services | Technical data, environmental data, third-party data (e.g. GPS location, points of interest) |
| | Fleet management services | Technical data, environmental data, third-party data (e.g. fuel consumption) |
| | Predictive maintenance | Technical data (e.g. wear on components) |
| | Safety and security | Technical data, environmental data (e.g. GPS location, driver's health condition) |
| | Infotainment with e.g. online music | Environmental data, third-party data (e.g. music streaming, driver's music preferences) |
| | Software-over-the-air/ Firmware-over-the-air | Technical data (e.g. component performance) |
| | E-commerce | Environmental data, third-party data (e.g. driver's preferences, online shopping service) |
| | Vehicle usage monitoring and scoring | Technical data (e.g. history of driving behavior, service history) |
| | Onboard delivery of mobility-related contents/services | Technical data, environmental data, third-party data (e.g. GPS location, driver's preferences) |
| | "Gamified"/social-like driving experience | Environmental data, third-party data (e.g. identity of driver and other drivers, third-party games) |
| | Remote car performance configuration | Technical data (e.g. component performance) |
| | Targeted advertisements and promotions | Environmental data, third-party data (e.g personal data about driver, promotions from vendors) |
| | Driving style suggestions | Technical data (e.g. driving behavior) |
| **Selling data** | Improving road infrastructure | Technical data, environmental data (e.g. vibrations in wheels, appearance of road) |
| | Aggregated car data-based CCTV service | Environmental data (cameras) |
| | Road laws monitoring and reinforcement | Technical data, environmental data (e.g. speed of own and other vehicles) |
| | Optimizing emergency assistance providers services | Environmental data (e.g. traffic conditions) |
| | Weather services | Environmental data (e.g. temperature, precipitation) |

*Table 7. The use cases identified in Chapter 4 and the data needed for them, sorted into the three different appropriation approaches identified by Wixom and Ross (2017).*

## 6.1 Improving Internal Processes

Like Wixom and Ross (2017) state, improving internal processes can be considered the most straightforward way of creating and appropriating value from data. It doesn't require new business models, and continuously improving processes by implementing new technologies and tools is something that automotive OEMs have been doing to some extent before.

### 6.1.1 A Fluid and Flexible Organization

In the theoretical framework research was presented that shows companies with well-developed use of analytics in internal processes outperform others, both financially and in terms of productivity. The same research suggests that the biggest challenges to actually reach a stage of well-developed use of analytics are managerial and organizational rather than technical. In line with this, interviews with NEVS (Interview 4) suggested that automotive OEMs have inertia in their organizational structures and that more fluidity is needed. Remembering what McAfee and Brynjolsson (2012) and LaValle et al. (2011) say is important when using data in internal processes, one could argue that organizational structures for automotive OEMs need to become more flexible and more cross-functional in order to let people who understand the data be brought together with the people who can actually translate the insights to action.

A way of becoming more fluid, flexible, and cross-functional in a time where vehicle manufacturing is becoming increasingly digitalized, could be to borrow management practices from the field of software engineering, where Agile development is common. Leybourn (2013) described how practices from Scrum and Extreme Programming can be used by vehicle manufacturers to achieve shorter and more predictable development processes, increased customer involvement and satisfaction, and higher quality outcomes. Such practices involve breaking down complex products into small, manageable tasks with incremental delivery from teams, more emphasis on continuous testing of modules, and closer dialogues with customers.

In practice, the concepts discussed could e.g. be implemented by breaking down the traditional organization of an automotive OEM into more specialized teams. With more teams working on specific tasks, that together build up a long-term strategy, more agility and flexibility could be achieved. With more focus being on the dialogues with customers, each team needs to engage with the customer to learn how the team's part of the complete product is being used. In this way a stronger and more thorough customer focus can be achieved, compared to the case where only a central function is engaging with customers. Observing the case of Facebook-Cambridge Analytica (section 5.4), one can argue that the lack of focus on the users is one of the reasons that Facebook has put themselves in their unlucky situation. Hence, to both create products and services that users/customers appreciate and to avoid losing their trust it can be beneficial for automotive OEMs to strengthen the relationship with users and customers. How vehicle data can accommodate closer customer relationships and more customized solutions is further discussed in the next section.

With interviewees (Interview 1, 5) arguing that new areas of application for data can be hard to find by OEMs themselves since they have little experience within the area of data analysis, it seems likely that collaborations and partnerships with outside companies will be important ways of supporting internal processes. For NEVS, with a strategy clearly influenced by a vision of a future where mobility-as-a-service rather than private vehicle ownership is the norm, this is especially true. With a focus on mobility services instead of private vehicle ownership, the value chain and the role of the OEM changes, new competencies become important, and partnerships with other firms become essential tools in encouraging flexibility. Collaborations between automotive OEMs and more technology-driven companies can already be seen happening in the automotive industry, with strategic collaborations announced between e.g. Volvo and Uber, GM and Lyft, and Tesla and Panasonic.

### 6.1.2 Optimization Through Customization

The case of Netflix (section 5.3) showcases how big data has been used to innovate in the media industry. The analysis of data collected by the product itself, the streaming media platform, has been used by Netflix to improve internal processes such as content creation and content recommendation. The improvements involve making content more customized to different parts of their audience and cutting out whole stages in the production. In a similar way, NEVS can become better at optimizing vehicles for its purpose by looking at how users, such as DiDi, their drivers, and passengers, use the vehicle. This is a prime example of what Prahalad and Ramaswamy (2004) refer to as co-creation. With all this in mind and knowing how customization is a way of creating value one can argue that optimization through customization is an important way in which value can be created from data within the automotive industry.

An example of how data can enable customizations is how data about vehicle speeds in urban populated areas could help NEVS in developing vehicles with a downsized propulsion system in favor of a bigger battery (Interview 4). This means that with data NEVS are able to innovate their value offering by not necessarily making vehicles better in every aspect but rather vehicles that better fit its purpose, though they may lack performance on some measures (as with a vehicle that have a downsized propulsion system but bigger battery). This way of removing non-essential features to reduce cost resembles the concept of frugal engineering. Efficiencies like these can be of value in themselves by lowering production costs while adding value to the user but can also be a way of making the business more sustainable. Sustainability is further an aspect that people are valuing more and more, and thus a type of value that data can help create through these efficiencies.

### 6.1.3 Data as a Complementary Asset

In many of the examples of innovations that have been mentioned, data can be viewed as an important complementary asset, a concept described by Teece (1986). In the case of Google and Facebook (section 5.1), it is apparent that these two companies have been successful in appropriating value as a result of them having unique access to large amounts of data. However, in the case of the automotive industry there are far more actors that possess similar data. In addition to there being many automotive OEMs that collect vehicle data, there are also mobility platforms such as Uber and DiDi that are well-positioned to collect useful vehicle data. In value chains where Uber and DiDi are involved they also control the user interface, which give them a unique access to some kinds of data. For this reason, automotive OEMs should not expect for data itself to be a unique asset. Instead, they should rely on a strategic use of its data.

The example of Tesla showcases that it pays off to have a strategic purpose behind collecting data, since their strategic data gathering has put them ahead of many other OEMs in the development of autonomous vehicles. In addition, section 4.2.4 showed that the amount of data needed for value to be created depends on which use it is intended for. Though this opens up for different possibilities, it also proves that the more data that automotive OEMs have, the more use cases are possible. This could put established players with a lot of vehicles on the road in a better position than smaller players to establish a competitive advantage based on data, as requirements of high scale would make it harder for smaller players to gather the required amount of data, in effect strengthening the appropriability regime of the asset. However, DiDi sharing data with NEVS is an example of how it is possible to gain control over data in other ways in order to offset the disadvantage of small scale.

Whereas collaborating with DiDi to gain access to data helps NEVS in the competition with other automotive OEMs, it also puts them in a position of dependence on an external actor (who in this case also is the intended end customer), subsequently potentially impairing their vertical bargaining power and appropriation potential. If a complementary asset is deemed critical, i.e. if commercial success is dependent upon whether or not it can be accessed, Teece (1986) recommends that the company should consider internalizing the complementary asset. In order to be able to compete with other automotive OEMs in the long run, while still making profits, even small OEMs should thus try to get direct access to critical data. However, as Manzi (2012) points out, companies that can integrate different types of data from different sources into analyses will outperform systems relying solely on internally generated data. Hence, external actors should be considered an important source of data, but OEMs should try and find ways that make them less dependent on external actors in the long term.

## 6.2 Enriching the Core Product

In this category, the ways in which data can improve the vehicle user's and/or owner's experience of the vehicle are elaborated on. These improvements are in the form of data-enabled products or services directed towards the user and/or owner of the vehicle. The value can then be appropriated by the automotive OEM either by providing extra revenue sources, or by making the vehicle itself more attractive to customers, in effect strengthening the competitiveness of the OEM compared to that of other OEMs.

### 6.2.1 Need for New Competencies

As mentioned in the previous section, 6.1, collaborations with new companies can support internal processes. The view that more collaborations are needed when creating value from data is further strengthened by Del Vecchio et al. (2018). It is also argued to be an important help in creating data-enabled services and products, which can go beyond the traditional scope of a vehicle manufacturer’s business. To visualize the extent to which new competencies are needed, Table 8 rates the different use cases (within the category of enriching the core product) on the basis of how well they correspond to the core competencies generally possessed by automotive OEMs. Those cases where competencies needed are in line with the usual core competencies of automotive OEMs, are argued to be cases where there is less need for collaborating with others. This argument is based on the discussions of Grant (2016) about basing strategy on core competencies. In contrast, cases where there are new competencies needed are cases where we argue that collaborating becomes more important.

As seen from Table 8, automotive OEMs would either benefit from or need to collaborate with third-party companies within the majority of use cases. However, the competencies needed to create value within each use case differ. This itself could be used to argue that a strategy for collaborating with a diversified set of external actors will need to be in place if automotive OEMs are to create value with more than a few of the identified use cases. In some cases (those without a check mark in the column titled *Collaboration with third party*) it is argued that NEVS would not necessarily need to collaborate with third parties. However, if choosing to collaborate with others they would benefit from the open innovation approach Enkel et al. (2009) call outside-in process. This approach involves less explicit collaborations but can be a way of strengthening core competencies by integrating external sources of knowledge. For example, predictive maintenance is closely related to total cost of ownership and an increasingly important part of automotive OEMs’ core competencies, especially as business models within the industry go toward offering mobility services rather than selling vehicles to individuals. The coupled process described by Enkel et al. (2009) also includes enriching the company's own knowledge base and for this reason could be another viable way of open innovation (for the cases without a check mark) that also includes more co-creating in the form of joint development and commercialization.

| *Use cases* | Collaboration with third party | Personalization |
|---|---|---|
| Usage-based insurance (UBI) | √ | √ |
| Usage-based tolling and tax | √ | √ |
| Connected navigation services (incl. e.g. points of interest, seamless navigation) | √ | √ |
| Fleet management services | | |
| Predictive maintenance | | |
| Safety and security (including e.g. E-call, stolen vehicle tracking, theft notification) | √ | √ |
| Infotainment with e.g. online music | √ | √ |
| Software-over-the-air/ Firmware-over-the-air | | |
| E-commerce | √ | √ |
| Vehicle usage monitoring and scoring | | |
| Onboard delivery of mobility-related contents/services | √ | √ |
| "Gamified"/social-like driving experience | √ | √ |
| Remote car performance configuration | | |
| In-car hotspot | | |
| Targeted advertisements and promotions | √ | √ |
| Driving style suggestions | | √ |

*Table 8. Showcasing for which uses that collaborations and personalization is either beneficial or needed to create value from data.*

Many of the use cases with a check mark in the column titled *Collaboration with third party* in Table 8 require competencies considered to be further away from the core competencies of automotive OEMs. For this reason, if choosing to strategically focus on areas more relating to core competencies, the strategy for creating value within these use cases would not need to involve the enrichment of their own knowledge. Enkel et al. (2009) describe the open innovation approach that they title inside-out process as transferring ideas to the outside environment, having less focus on enriching the company's own knowledge or co-creating with others. For example, both user-based insurance and user-based tolling and tax would have to involve own data and data analytics but also involve areas like insurance and tolling and taxing, in where NEVS have no current competencies. NEVS could thus simply sell or give access to the required data to insurance companies and let the insurance companies do most of the work in creating the service. However, one could also argue that the coupled process (mentioned above) is an option, with it serving as a middle ground that involves co-creation while still not having a focus on enriching the company's own knowledge base, in which case NEVS would play a bigger role in jointly creating the service with the insurance company.

Creating value within the use cases where automotive OEMs have less core competencies does not necessarily need to be involving collaborations with others. Though this is arguably the quickest and most reliable way to get access to new competencies, one could also argue that automotive OEMs can find other approaches to create value that have less involvement of others. One of those approaches that car companies could choose to adopt is diversification. Creating a new division or group to provide this new service, that works within the same company, could be a way of appropriating more of the value that the data is helping to create. However, diversifying could potentially put automotive OEMs in great uncertainty and risk of detracting the focus from the core business.

### 6.2.2 Creating Value Through Personalization

Collecting data allows for more customized products in general, which is why all the use cases for data involve some kind of customization. However, personalization, i.e. customization to a specific individual based on personal data, is not needed in all of the use cases. Table 8 provides an assessment of whether personalization is needed or beneficial in each case, based on whether personalizing the service for each user is needed for the use case to work. The table reveals that personalization in many cases would improve the services, contrasting the view that the most commercially interesting opportunities with vehicle data are based on aggregated data.

Simultaneously looking at the collaboration and the personalization columns in Table 8 also reveals that many of the use cases require both collaborations and personalization. New regulations (e.g. the European GDPR) requiring data collectors to get explicit consent from users to both collect data and to share the data with third parties for each specific use complicates matters for these specific cases. The case of the Facebook/Cambridge Analytica scandal (section 5.4) made it obvious that companies need to be careful with the way in which they treat personal data, especially in cases where both personal data and a third-party collaborator are involved. Further, it is still unsure how future regulations on personal data will look. However, personalization is a driver of value, which makes it relevant to try and find a successful way to approach mentioned use cases. If choosing to create services that involve both personal data and collaborations, it is important to take legal aspects into careful consideration. Strategically eliminating or minimizing the risks connected to the use of personal data is a way to successfully appropriating the value that can be created through these use cases.

There are ways in which automotive OEMs could successfully overcome the potential problems of using personal data. The easiest and most obvious way is to not use personal data at all, but as mentioned this can lead companies to miss out on potential revenue streams. It is when the personal data needs to leave the vehicle, to be stored or cross-analyzed with third-party data, that the legal issues arise (Interview 2). Therefore, one possible option of using personal data is eliminating the need for it to leave the vehicle. However, it is self-evident that this option of eliminating the step of the data leaving the vehicle is not a viable option for all cases. For these other cases, using encryption to anonymize data can be a way to ensure personal integrity for customers/users. Though this can be seen as the solution viable for most cases, anonymized data could also be reducing the possible value that can be created from data, by removing means of personalization.

### 6.2.3 Organizing a Platform Business

In addition to already mentioned aspects, Table 8 makes it apparent that if companies are to create value within each of the identified use cases it will be crucial to collaborate with many different types of companies, and in many different ways, due to the variety of use cases. To be able to handle collaborations with a wide range of companies, while being adaptive and responsive to changing customer needs, a platform model where car users/owners, third-party service providers, and the OEM itself can meet might therefore be a viable solution. In addition to being a channel between third-party service providers and users (Hagiu, 2014), a platform offers users of the platform (and the vehicle) the value of customization. Through the user interface a user could theoretically customize their vehicle by choosing which services to enable and disable. With Capgemini (n.d.) stretching the importance for automotive OEMs to transform their product-oriented strategy to a customer and service focus, one could argue that taking a step towards enabling more customization is a step in the right direction. Further, data collection from the services provided through a platform would give automotive OEMs access to more user data in the form of e.g. how services are used and how users interact with the platform, enabling more customizations of the platform to be made in a process of co-creation.

The business model for a connected vehicle service/app platform could have similarities to how e.g. Apple's iOS and App Store works. Using Osterwalder and Pigneur's (2010) terminology, the two *customer segments* that are being served are users of connected vehicle and third-party app or service developers. The *value proposition* for vehicle users is the ability to customize through easy access to apps available through the platform. For service/app developers the value proposition is an environment for development of services and apps using vehicle data and a channel to the vehicle users through the market provided by the platform. The *revenue streams* from vehicle users could derive from both subscription fees for using the platform and/or premium prices for the vehicle itself. The revenue streams from service/app developers can derive from licensing fees, percentage of revenue made from the platform etc. Table 9 summarizes what important parts of the potential platform business model for connected vehicles might look like.

| | | |
|---|---|---|
| **Customer Segments** | Users of connected vehicles | Service/app developers |
| **Value Propositions** | Customization through easy access to apps and services | Development environment with access to vehicle data and a channel to users via market |
| **Revenue Streams** | E.g. subscription fees, premium vehicle prices | E.g. licensing fees, percentage of revenue made from the platform |

*Table 9. Important parts of the proposed platform business model for connected vehicles.*

Like the case from the smartphone industry in section 5.5 illustrated, and like Grant (2016) writes, a characteristic of digital industries, which the automotive industry is more and more resembling, is that both developers and users tend to gather around the market-leading platform because of network effects. In the smartphone industry nearly all OEMs except Apple have gathered around the Android platform, stripping most OEMs of much of the revenue potential, similar to how nearly all PC manufacturers have gathered around Microsoft Windows and struggle to make profits themselves. Having in mind what happened in the early days of smartphones, with early market leaders such as Nokia and BlackBerry failing, and a couple of years passing before the “winning” platforms had emerged, a similar development within the vehicle industry is not unthinkable as vehicles are becoming smart. Automotive OEMs should therefore try and avoid a situation similar to that of smartphone OEMs and PC OEMs. This could potentially be done by jointly developing a platform and sharing the revenues created by it.

Having mentioned Android as an example of a successful platform (section 5.3), it is also worth further elaborating on Google and Android’s position in the automotive industry. Google has been diversifying into different industries throughout the years, one of which has been the automotive industry. Android as an operating system has already been adopted by vehicle manufacturers such as Alfa Romeo, Volvo and Audi. Though this is a kind of platform that uses data to offer services, it is as of today not offering all the services that are identified in Table 8. It does, however, offer some of the services that the proposed platform approach (described above) would offer. Thus, developing a platform that offer services for user/owner of the vehicle could put automotive OEMs in direct competition with Android, that arguably has had a head start in offering a service platform.

### 6.2.4 Strategic Sacrifices

Offering services on a platform would arguably mean more collaborating and handing over part of the value creation process to third-parties. This could be seen as obstacle for automotive OEMs, who for obvious reasons want to appropriate as much of the revenue as possible. However, sharing too little of the revenues with third-party developers will lead them to be less inclined to develop services. Thus, automotive OEMs will need to strike a balance in how much revenue that is shared in comparison to how much they appropriate themselves. A key is therefore also to gain an architectural advantage, described by Jacobides et al. (2006) as a state of high competition in adjacent segments of the value chain and low competition in one's own sector. In this case it would mean a situation with high competition among third-party service providers, but only few competing platforms. Thus, automotive OEMs should engage in activities that take advantage of network effects, to reach a critical mass of services and perhaps exercise less bargaining power over third-party developers to better be able to compete horizontally against other OEMs.

Though monetary value in the short-term may be what companies prefer the most, acknowledging that it may be important to sacrifice rewards in the short-term for long-term benefits leads us to note the importance of having a broad view of value. Google's approach to counter Apple's emerging dominant position with developing an open-source operating system in the smartphone market (section 5.3) is an example of a company successfully making this strategic choice. With the applications of vehicle data not yet having reached its full potential, there is going to be competition between actors wanting to create and appropriate as much of the value from data as possible. In turn, companies that strategically sacrifice short term monetary rewards to gain a more rapid diffusion of their innovations, network effects, and conclusively long-term value, may be the ones that end up the winners.

## 6.3 Selling Data

Though Wixom and Ross (2017) claim that selling data is the hardest way to monetize it and Faktor (2015) dissuade companies from doing so, section 4.2.3 clearly showed that there is a broad range of ways in which vehicle data can be valuable for external actors, both related and unrelated. From these findings, one could argue that automotive OEMs would benefit from using what Enkel et al. (2009) refer to as the inside-out process of open innovation. In the inside-out process, internally generated IP, in this case data, is transferred to the outside environment through some sort of agreement to be put to productive use by external actors and generate alternative revenue streams. However, as the interviews with external actors showed, the area is so new that the potential customers do not know themselves exactly how this value can be created. This is much due to the fact that there is today no way for them of knowing what the databases that vehicle manufacturers control contain, in contrast to other forms of IP, e.g. patents for a specific technology for which the possibilities can be quite easily assessed by simply reading it.

### 6.3.1 Selling Data to Vertically Related Actors

The cases of data selling in other industries (see section 5.5) showed that the most viable way to sell data so far seems to be to sell it to vertically related actors, with whom relationships already exist and for whom the value of the data may be clearer**.** In the same way that data from DiDi can help NEVS in optimizing their vehicle, data from NEVS can also help their suppliers in optimizing component performance. A vehicle consists of parts manufactured by many different suppliers, who can benefit by getting access to data about how their different components function as parts of the full system. As such data can be collected by the automotive OEM, but in some cases also by the component manufacturer itself, contractual agreements become important for who gets access to the data, in line with arguments made by Joyce (2017), Mayer-Schönberger and Cukier (2017), and NEVS (Interview 2). To exemplify, a supplier of brake discs may want to install sensors in its products to get data about how well they function, how fast they wear out etc., that it can use to develop better brake discs and thus become more competitive with other suppliers of brake discs. With the vehicle manufacturer controlling the ECUs of the vehicle, it should be in a better situation to gather that kind of data and also combine it with other relevant data sources. Access to such data can thus strengthen the OEM's position in contract negotiations with the supplier and be a part of deals in exchange for cheaper components.

### 6.3.2 Packaging Data

The interviews revealed a few prerequisites for vehicle data to be useful to unrelated actors. First, sufficient amounts of connected vehicles are needed to make data representative (Interview 5, 10, 11). Second, the external actors want data to be easily accessible and well-structured. Third, data need to be reliable, verified and well-documented. These prerequisites say that merely obtaining interesting data is not enough to create value, it also has to be packaged in a way that makes it easy to use and extract insights from for external actors. This is in line with an argument made by Manyika et al. (2011), that data needs to be accessible to those stakeholders that can gain value from it in a timely manner. In a situation where all vehicle manufacturers have similar technical capabilities of obtaining vehicle data, the most viable way to stand out in the competition might be to create value by packaging data in a better way, and thus make the data itself more useful.

Abilities to package data in such a way can thus be viewed as an important complementary asset to data, similar to how Teece (1986) mentions distribution systems as important complementary assets to physical goods. Section 5.5 provided an outlook on how data is being sold in other industries and described how data can be commercialized either in the form of raw data or in more embedded forms, ultimately resembling a service delivering insights based on data to the customers. Accenture Strategy (Gissler, 2015) recommend standardized APIs as a way of enabling seamless integration of third-parties, which in the case of traffic data is something that is already implemented by TomTom (see section 5.5). In most cases, however, the most successful examples of selling data seem to be in the shape of insight services similar to e.g. predictive maintenance services (see section 5.5). The portfolio manager at Trafikverket (Interview 7) also expressed that insight services are a more interesting form for them to buy vehicle data, than in the form of raw data.

### 6.3.3 Co-creating Value with External Actors

Both the portfolio manager at Trafikverket (Interview 7) and the climatologist at SMHI (Interview 9) argued that for them to start paying for data, the benefits have to be clearly shown beforehand, and that they also are willing to collaborate with vehicle manufacturers to find these benefits. This indicates that a process of co-creation, as described by Prahalad and Ramaswamy (2004), where the customer is involved in the process of identifying the needs and creating the product or service, is needed. In such a process of co-creation, knowledge is created and shared between the two actors to hopefully benefit both of them. In the terms of Enkel et al. (2009), a coupled process of open innovation can be used, where the inside-out process is combined with an outside-in process of gaining knowledge of how vehicle data can be used to benefit others. With this knowledge it can possibly be easier for vehicle manufacturers to move towards a purer inside-out process at a later stage.

A more specific recommendation would be to initiate pilot projects in close collaboration with certain potential customers, whereafter the learnings from those projects can be used to create more general value propositions that can be offered to a wider range of customers. For example, a project could be initiated with Trafikverket to develop a method for connected vehicles to recognize potholes and other forms of road wear before they have become dangerous issues, and to send concrete information to Trafikverket about when it needs to be fixed and what needs to be done. With the stamp of approval that Trafikverket can give the service, it could then be sold to authorities in other countries as well.

Even if using an approach that involves co-creation, creating insight services for new and external actors would require an entirely new business model and consequently a new set of competencies and specialized skills that are not found within most automotive OEMs today. For example, it would require skilled data analysts with some knowledge about other industries, for them to identify potential customers and also help them to gain valuable insights. Experience from or knowledge about the automotive industry is less important for these employees. In addition, packaging the data in the form of insight services (noted as important above) would require a new type of data analysts than those important in improving internal processes, since knowledge in packaging data not necessarily is something that is needed when the company itself is the user.

While most of the use cases that were identified within this category include primarily anonymous data, there certainly are imaginable possibilities for how sharing personal data about users with external actors might accommodate value creation.

However, as the Facebook-Cambridge Analytica scandal (section 5.4) spectacularly showed, this carries some risks of causing outrage among the users themselves, as well as among lawmakers and might also cause potential buyers of the data to be more careful. As the legal boundaries set by the upcoming GDPR are still quite diffuse and public opinion about privacy issues is unpredictable, one could argue that automotive OEMs in first hand should look to anonymized, aggregate level data and be careful in their treatment of personal data, as selling personal data is still uncharted territory for automotive OEMs and the “rules of the game” still need to be set.

# 7 Concluding Discussion

In this concluding chapter we summarize and discuss what the thesis has revealed about how automotive OEMs can create and appropriate value from vehicle data. This discussion also provides answers to the three research questions that were posed in section 1.2:

RQ1 What kind of data can be collected from a technical and legal point of view?
RQ2 How can value be created from connected vehicle data?
RQ3 How can value created from data be appropriated by vehicle manufacturers?

The first research question was answered already in chapter 4, which revealed that almost all conceivable data about the vehicle itself or about its direct environment can be gathered by a connected vehicle and combined with third-party data from other sources. It is only a matter of how many sensors the manufacturer wants to put in the vehicle. The challenging part is to find uses for the data and decide what analyses that should be performed. In addition, advanced cross-analyses of data is the costliest part since cloud environments charge for data transactions rather than storage. All in all, the technical limitations of what can be done with data are small, and the challenges that lie before owners of data are intellectual rather than technical in nature.

The legal limitations of what can be done with data are above all connected to data protection regulations and concern personal data, i.e. data that can be connected to a specific person. For a company to be able to collect personal data about an individual, clear consent has to be given from the person in question. This might face OEMs with some challenges since non-personal data in combination with other data can become personal. A way to handle this is to avoid looking at data on the individual level and instead focus on data on an aggregated fleet level. By solely focusing on fleet level data it is however possible that potentially valuable usage areas for data is missed.

Research questions 2 and 3 were analyzed and answered conjointly in chapter 6. The analysis was structured around three overall approaches that vehicle manufacturers can choose to appropriate value from their vehicle data. Analysis of how value is created and important factors deciding how much of the created value that can be appropriated by the OEM was then performed within each category. Table 10 summarizes what the empirical findings and the analysis revealed.

| Appropriation Approach | How value is created | Important factors affecting appropriation potential |
|---|---|---|
| **Improving internal processes** | Data enables co-creation with vehicle users by letting OEMs learn how their products are used, giving them opportunities to better optimize/customize products to the users' needs.<br><br>To successfully create value from data, organizations need to become more fluid/flexible which can be done by adopting practices from the IT industry. | In the competition between automotive OEMs, data can prove to be a critical complementary asset. In these cases, data collection should be internalized.<br><br>Having direct access to important data improves both competitiveness and vertical bargaining power. |
| **Enriching Core products** | To create data-enabled services, OEMs must collaborate with a range of other companies. A viable way to this is to use a platform model similar to what is common in the smartphone industry.<br><br>Data enables personalization of certain services which can be valuable but comes with risks. | With data-enabled services becoming an increasingly important part of the value proposition, automotive OEMs should focus more on enabling collaborations with service providers than on maximizing bargaining power.<br><br>Creating a platform for data-enabled services, the platform owner could potentially appropriate most value. OEMs could solve this by jointly developing and owning a platform. |
| **Selling data** | Abilities to package data in an attractive way is important. The most viable way to package data is as insight services.<br><br>External actors are willing to collaborate and experiment to find ways of creating value with data. | Access to data can be used to increase bargaining power over suppliers and/or optimize components, why OEMs need to be meticulous when contracting access to data. |

*Table 10. A summary of the analysis.*

Like the analysis and earlier chapters have shown, opportunities for creating value from data abound. While this of course is good news for companies in possession of data, it also brings difficulties in terms of which opportunities one should focus on. Weill and Woerner (2015) and Grant (2016) claim that a clear strategy to guide one's choices is especially important in times of a changing external environment. For an automotive OEM to make the right decisions about what data opportunities to focus on to appropriate as much value as possible, they should therefore look to how data best can accommodate them in fulfilling their strategy. Section 4.2 presented the case of how Tesla installed sensors gathering data to support the development of their autopilot years before the autopilot was released to customers and incrementally updated in the form of OTA software updates. This is an example of how they used a long-term product strategy, developing an autonomous drive vehicle, to decide already at an early stage what hardware to build into the vehicle.

It should also be noted that there are examples of companies that have chosen other innovative approaches in handling data, where the intent is less clear. Uber has offered traffic data gathered on their app to the public for free, and one can only speculate what the strategy behind it was. The choice of offering data for free may have been made to improve their image and get some good publicity, which might prove very important for a company facing opposition from lawmakers and strong taxi unions. The motive may also have been to create a demand that can later be monetized, or something completely different. In other cases, e.g. in the case of NEVS with a strategy of delivering fleets of vehicles for a very specific use with the lowest total cost of ownership possible, the decisions of what data opportunities to go after will have to be different.

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# Appendix

Below are the questions that were used to guide the writers in the different interviews. For the interviews held in Swedish the questions are presented both in Swedish and English.

**Interviews at NEVS**

*Car Connectivity Manager, 2018-02-12*

- Vilken data kan ni samla in idag? Inom vilka områden kan data samlas in i?
- Vad gör ni med data som samlas in idag?
- Vilken data lagras idag? Och varför?
- Vilken data lagras inte? Och varför?
- Hur lagras den data som samlas in?
- Hur mycket kostar det att lagra data?
- Hur kan data analyseras, inhouse? Med vilka hjälpmedel/tekniker?
- Vilka användningsområden ser ni med den data som idag går att samla in?

- What data can you collect today? In which areas can data be collected?
- What do you do with data collected today?
- What data is stored today? And why?
- What data is not stored? And why?
- How is the data collected?
- How much does it cost to store data?
- How can data be analyzed, inhouse? With which tools/techniques?
- What uses do you see with the data that can be collected today?

*Business Development Manager, 2018-02-12*

- Tycker ni att lagstiftning är ett hinder för vilket värde ni kan skapa med data?
- Vad för lagstiftning begränsar vad ni får göra i Europa/Kina/USA?
- Får vilken data som helst samlas in och lagras?
- Får vilken data som helst processas/analyseras?
- Får data överlämnas till tredje part?
- Hur villiga är kunder att dela med sig av personlig data?

- Do you think legislation hinders what value you can create with data?
- What legislation limits what you can do in Europe/China/USA?
- Can any data be collected and stored?
- Can any data be processed/analyzed?
- Can data be handed over to third parties?
- How willing are customers to share personal data?

*Vice President Product Strategy & Planning, 2018-02-12*

- Vad för data/dataanalyser tror ni kan skapa värde (för er eller andra)? Och för vem (vilka är intressenterna)?
- Vad är viktigt för att ni ska kunna tjäna pengar på er data?

- What data/data analyses do you think can create value (for you or others)? And for who (who are stakeholders)?
- What is important for you to make money from your data?

*Attribute Performance Manager, 2018-04-11*

- How does the product development process look today?
- How can you create value from data in your product development process? Cutting costs/improving product?
- How have learnings from previous product generations been incorporated into new product development earlier?
- When looking at data and extracting insights about things that could be improved, what are the steps in actually translating these insights into action?
- Do you think that the organizational structure has to change in some way for it to be better at translating data insights into action?

**Industry experts**

*Postdoctoral Researcher, 2018-03-02*

- Can you tell me a little bit about yourself and what you do research on?
- What is the Internet of Things and how is it affecting the automotive industry?
- What kind of different business models for monetizing data from connected things do you know of? Which have so far been the most successful? Examples from other industries?
- What do you think is needed to create value from data collected by cars?
- What possibilities do you see with collected data in the automotive industry? What use cases?
- How does car data create value for car manufacturers? (e.g. internally/externally)
- With the automotive industry moving more towards offering data enabled services, how do you think that the role of the vehicle manufacturers in value creation will change?
- As value becomes increasingly co-created by different actors/partners, what do you think is important for vehicle manufacturers to capture the value?

*IP Consultant, 2018-04-11*

- Teece talar om svaga och starka appropriability regimes. Hur tror du det ser ut för vehicle data? Vi har tänkt att de blir svaga eftersom många aktörer får tillgång till ungefär samma data.

- Teorierna om appropriability handlar mycket om att skaffa sig tillgång till complementary assets och skaffa sig bargaining power över de som har tillgång till dessa. Vilka är viktiga complementary assets?
- Hur får man bargaining power över de som innehar dessa complementary assets?
- Utöver det vi kommit fram till från teorier, är det någonting mer du anser är viktigt för att automotive OEMs ska kunna skapa värde från data som de även kan appropriera?
- Hur ska automotive OEMs undvika att hamna i samma situation som tex PC-OEMs där tier 1-suppliers tar all profit?
- I vår analys utgår vi från tre områden inom vilka man kan skapa värde; usage by (1) the OEM itself, (2) the car user and/or owner och (3) external actors not directly related to the car. När man skapar värde internt, såsom att optimera R&D, så är det uppenbart lättare att appropriera värdet själv (jämfört när man är skapar värde åt andra). Hur tror du approprieringen, eller hur man lyckas med appropriering, skiljer sig mellan dessa kategorier?

- Teece talks about weak and strong appropriateness regimes. How do you these are for vehicle data? Our thought is that they are weak because many players have access to almost the same data.
- The theories about appropriability are a lot about gaining access to complementary assets and gaining bargaining power over those who have access to them. What are important complementary assets?
- How do you get bargaining power over those who hold complementary assets?
- In addition to what we have learned from theories, is there anything more you think is important for automotive OEMs to be able to create value from data that they also can appropriate?
- How should automotive OEMs avoid ending up in the same position as PC OEMs, where tier 1 providers take all profits?
- We base our analysis on three ways in which value can be created; usage by (1) the OEM itself, (2) the car user and/or owner och (3) external actors not directly related to the car. When creating value internally, such as optimizing R&D, it is notably easier to allocate the value itself (compared to creating value for others). How do you think the appropriation, or managing appropriation, differs between these categories?

**Potential customers**

All potential customers were asked:

- Uppkopplade fordon kan samla in data om [insert bransch-specifik info]. Skulle sådan data vara av värde för er?
- Skulle data från uppkopplade bilar kunna ersätta data som ni idag samlar in på annat sätt? Hur mycket pengar lägger ni idag på att samla in data som skulle kunna ersättas av data från alla fordon på våra vägar?

- Skulle data från uppkopplade bilar kunna ge er ny data som ni idag inte har?
- Vad tror du skulle krävas för att ni ska betala för sådan data från bilar?

- Connected vehicles can collect data about [insert industry specific info]. Would such data be of value to you?
- Could data from connected vehicles replace data that you collect in other ways today? How much money do you spend today on collecting data that could be replaced by data from all vehicles on our roads?
- Would data from connected vehicles give you access to new data, i.e. data that you can not collect today?
- What do you think would be required, for you to pay for such data from vehicles?