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The Transition to Autonomous –

Impact & Challenges in the Race toward Self-Driving Cars

Master of Science in Innovation and Industrial Management

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Abstract

Background and Problem

Artificial Intelligence (AI) and specific Machine Learning (ML) are on the verge of gaining traction and significance within every industry. Learning Machines will lead to Automated Vehicles (AV), able to take judgement and decisions and ultimately steer themselves. This development will be the greatest disruption of the car automotive industry in the past hundred years. Organizations are forced to adapt to such a radical change in order to stay competitive and fulfill their customer needs.

Purpose

This dissertation examines the effect of ML-enabled Autonomous Driving (AD) on car manufacturers until 2030. It does that under two different lenses: First, the effect on the value proposition and the business models of the car manufacturers. Second it identifies hurdles for the implementation and draws strategic implications for the car manufacturers.

Method

This dissertation uses a qualitative research approach to answer the research questions, comprising of a multiple-case study using semi-structured interviews in order to gain insights from a number of relevant experts from different organizations. The primary findings are complemented by a secondary research that through triangulation assists identification of hurdles, which computed in a scenario analysis assess level of AD available in 2030.

Results and Conclusion

The effect of AD within the car automotive industry for car manufacturers is subjected to the hurdles of technology progress, legislation, need for new competencies, the need to collaborate, costs, ethics, safety & customer trust. By 2030 the likeliest scenario is that fully autonomous vehicles are solely available for particular high value use cases, affecting the value proposition toward provision of mobility services, increase of customer- & value-centric value propositions fostered by continuous interactions between the OEM and the user.

Keywords

Autonomous Driving, Trends within the Automotive industry, Business model, Value proposition, Innovation Management, Servitization, Artificial Intelligence, Machine Learning

Table of Abbreviations

AI	AI
ML	ML
AD	AD
AV	Automated Vehicle
OEM	Original Equipment Manufacturer
LIDAR	Light Detection and Ranging
ADAS	Advanced Driving Assistance System
SAE	Society of Automobile Engineers
ODD	Operational Design Domain
P2P	Peer-to-Peer
MaaS	Mobility as a Service

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1 Introduction

1.1 Preface

Artificial Intelligence (AI) is claimed to be the most disruptive and game changing technology for several industries during the 21st century. Particularly machine learning (ML), which is the ability of a machine to improve its performance by learning from previous examples about the desired outcome of a task. There are two main reasons for this. First, AI-technologies will enable a never before seen degree of automation within organizations, since a lot of tasks being conducted by humans nowadays can be replaced by machines. Second, ML could eventually enable machines to achieve superhuman performances in their areas of expertise (Brynjolfsson & McAfee, 2017).

AI and ML will have the greatest effect on industries that are already highly digitally adapted such as the financial industry, telecommunication industry and the automotive industry. This is due to complimentary technology being established in these industries (Bughin et al., 2017). Experts predict that especially the automotive industry will be disrupted during the 21st century, due to four underlying trends within the industry: Diverse mobility, Autonomous Driving (AD), Electrification and Connectivity.

This Master Thesis aims to clarify how AI, especially ML will affect the automotive industry with one of these key trends, Autonomous Driving. In the latter the authors' refer to ML as the main technology of the thesis. Self-driving cars, prior thought to be inconceivable, has in recent years seen major technological advances, to a level where Alphabet's autonomous car unit Waymo has started to invite volunteer passengers to ride in its pilot driverless cars (Bergen, 2017). It entails a possible transition in the industry, which carries large changes in automakers business models, alterations of needed resources and capabilities to effectively compete, and most importantly the industry's value propositions. Simultaneously, several critics claim that autonomous driving is far from being realized, and that car original equipment manufacturers (OEMs) and technology companies alike are making bold statements of market introduction in the next few years despite the many obstacles that have yet to be overcome (Simonite, 2016).

1.2 Problem Discussion

The increasingly dynamic business environment, propelled by the introduction of novel technologies, is set to be facing another technical revolution. AIs increased relevance and potency for disruption is the cause for several prominent companies, such as Google and Amazon, to invest significant funds into research and development combined with acquiring talent in order to sustain competitiveness. In an age where technology can facilitate the entry of such organizations into other industries it becomes even more challenging to predict the future. The automotive industry is one such industry, where in recent years new entrants have entered enabled by technology to challenge the incumbents. It thus provides for a highly relevant and interesting analysis to study the implications for the players in the industry with the introduction of AI technologies in a rapidly changing competitive landscape. Certainly, as numerous professional service firms and scholars are studying the subject the uniqueness can be questioned, however putting the center of attention to the value proposition gives the thesis a distinctive purpose. To focus on the industry value proposition puts a key aspect under the scholar lens, as it comprises the core definition of how these firms provide value to their customers. AI and ML in particular is set to redefine this proposition, and hence gives researchers a further exploratory outlook when studying the industry.

Even with all its promise of disruption across industries, AI technologies are still in a fledgling state and its further potential on businesses and organizations cannot be fully determined yet. Although showing promising impact on automation of routine tasks, such as back office operations in financial institutions (Deloitte, 2017) and certain manufacturing procedures (Bughin et al., 2017), it is still uncertain if it can be successfully transferred and implemented to many applications. However, given time it is indicated that the technologies will develop to further encompass a greater array of automation tasks that will increase efficiency & productivity, and already shows greater capacity than humans in certain tasks (Brynjolfsson & McAfee, 2017). In the automotive industry it is believed that the result of ML applications will see the first major commercial application of the technology, self-driving cars (Hempel, 2017). Combined with the electrification of powertrains, changing mobility habits and ubiquitously connected vehicles the business landscape is set to unravel, impacting offered products, services, consumer behavior, organizational structure and business models. To what degree the impact will be is hard to define and also when, albeit it can be presumable that the dawn of AI will carry radical implications for the car manufacturer business model, as it is conceivable that cars could be provided as services in themselves rather than the current product-centric industry paradigm.

A business model typically explains how a firm creates or generates value and how it captures some of the value as profit known by researchers as value capture. Business model innovation has also been described as the process of finding a novel way of doing business which results in reconfiguring of value creation and value capturing mechanisms (Bashir & Verma, 2017). A central element of a business model is the value proposition, which determines the value of the product or the service offered is delivering to the customer. A conventional value proposition of a car manufacturer could be “Providing a device that the customer can use itself to get from point A to B reliably, safely and flexibly”. In the context of ML and AD this conventional value proposition and the business model that is based on it might drastically change and hence business model innovation must be an area of focus for organizations. Such a radical change in the business model will inevitably also lead to changing organizational structures. Operational models have to be reconfigured, and management needs to foster and focus innovation into these novel spaces. Companies need to be prepared for changes in their structures, such as the emergence of new business units and areas of work. In the context of the above described trends of the potential of ML and its strategic implications, ML will pose opportunities and challenges on organizations. The following thesis will elaborate those and give strategic advice.

1.3 Research Question

The research inquiry focuses on one key component of the automotive industry that is affected perhaps the most by the use of AI technologies, the cars themselves that potentially can be transformed into autonomous mobile robots. Looking at a time horizon of approximately ten years into the future, the authors aim to provide an explorative account of how self-driving cars can evolve and change value propositions within that timeframe. The reason for analyzing the industry development within this particular timeframe is to limit the thesis scope, and that an analysis for the years beyond is likely not accounting for new technologies that might emerge that can alter the anticipated business case. Further, as it is increasingly difficult to forecast the future due to dynamic and volatile business landscapes it reduces the external validity of the thesis significantly if a longer timeframe is chosen.

Because of time constraints, the limited scope of this paper and the properties of the technologies written, this thesis may not yield results that provide a comprehensible forecast exhausted with all possible options to contribute to the field of research. However, the results may add aspects and dimensions that can contribute to the discussion topic, and thus promote further research into the area.

Considering the aforementioned themes, the following research question can be asked:

"How will the car manufacturers' value proposition be affected by automated vehicles enabled by machine learning technology until 2030?"

To answer the primary research question it is required to identify the obstacles for automakers to implement these vehicles, as it entails the speed and likelihood of usage of AV within the timeframe. Hence, to cover these factors and analyze their implications on the primary research question, the secondary research question is as follows:

"What are the major hurdles to car manufacturers' implementation of automated vehicles?"

1.4 Limitations

Firstly, this thesis focuses on the value proposition of car manufacturers as opposed to the wider spectrum of motor vehicles included in the term automotive, such as buses and trucks. Secondly, the paper focuses on concepts related to the value proposition and aspects that are necessary to consider in its reevaluation, such as matching resources and capabilities and innovation management. Value proposition is a core component in the business model concept; however this thesis does not carry the purpose of describing a comprehensive shift of all components in the automotive business model, but solely provide an overview of how changing value propositions can affect the current industry paradigm. Third, the aim of the thesis is not to implore the technical specifications of ML technology, but rather to give an overview of said technologies and focus on business applications of its utilization. The reason why the focus is put on the cars in comparison to the wider automotive industry as a whole is due to the difference in proposition offered per category, which can be widely different from another. Indeed, providing foci that is too wide would undermine the external validity of the research findings. Given more time and resources such an analysis could have been conducted. Additionally, as the researchers concentrate on business applications it is deemed to enable better categorization of certain concepts found during the research related to business models as opposed to studying technology in detail. Lastly, the thesis scope was limited to analyze a particular timeframe until the year 2030. The reason is to facilitate a scenario analysis that which assesses how the different hurdles identified in the second research question likely will impact the development of the phenomena of self-driving cars. Naturally, as this thesis argues, the future cannot be fully anticipated and foreseen. However, it aims through its inquiry contribute to the field of thought regarding the future state of the industry.

2 Literature Review

The following passage discusses key concepts used in the analysis and evaluation of the primary and secondary data gathered.

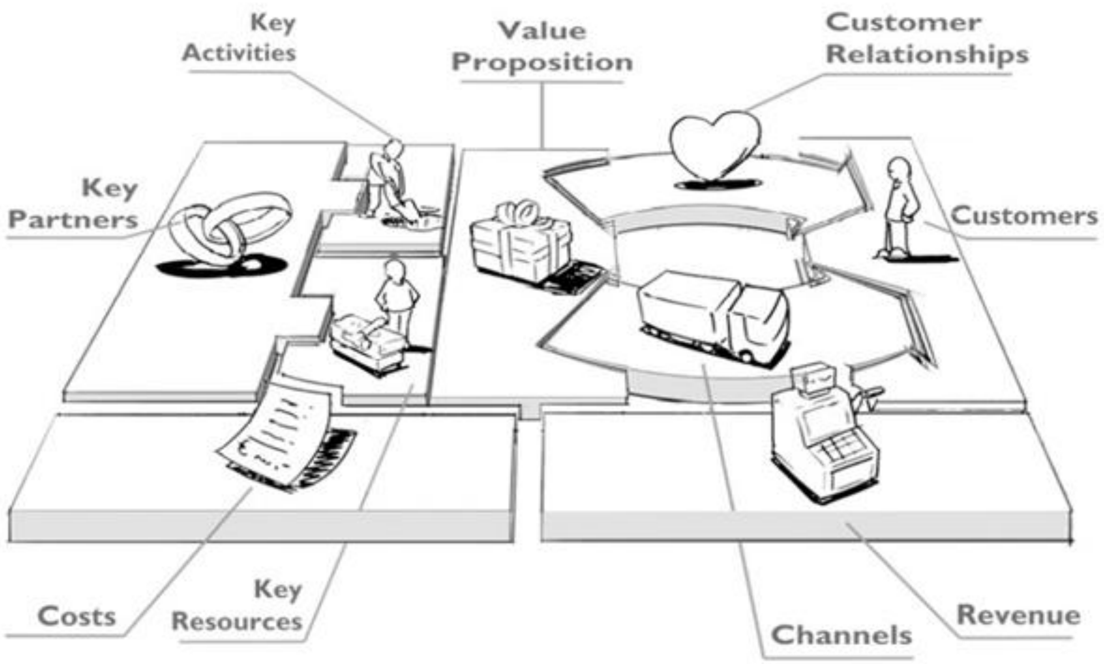
2.1 Business model and Business model Canvas

In the following the concept of a business model will be elaborated. It will lay the basis for the understanding of the importance of the value proposition. In the analysis of the thesis the authors will mainly refer to the idea around the value proposition.

The concept and the definition of a business model is of a rather complex nature and hence researchers so far, do not agree on a common definition for the term business model. However, for this Master Thesis a business model is defined as *"a way an organization delivers, realizes and captures it´s value"*. This definition is broadly applied by researchers. A Business model lays the basis for an organization's actions, strategies and its structures in order to project and generate the greatest value to the customer (Joyce & Paquin, 2016).

One of the most common tools in the context of business models it the business model canvas, illustrated in figure 1.

Figure 1 - Business model Canvas (Source: Osterwalder & Pigneur, 2010)

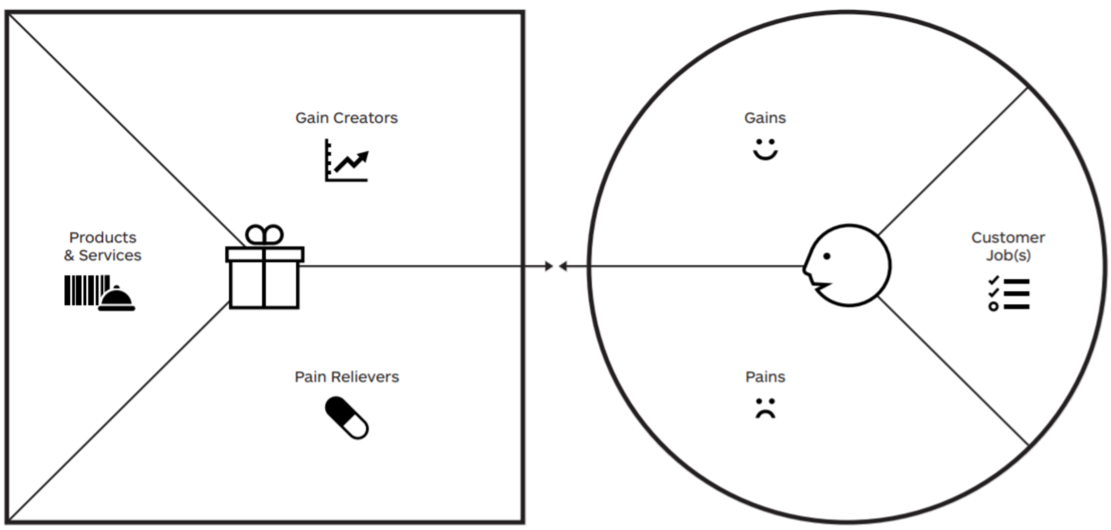


The Business model Canvas is a structured approach of breaking down the Business model in 9 categories. The relationship between the categories is displayed and hence it can be used in an analytical manner to see how different actions are having different influences on the business model of an organization. In the context of the research questions, the following Master Thesis will focus on the most central element of the Business Model Canvas: The Value proposition.

2.2 Value proposition – A Market Value Concept

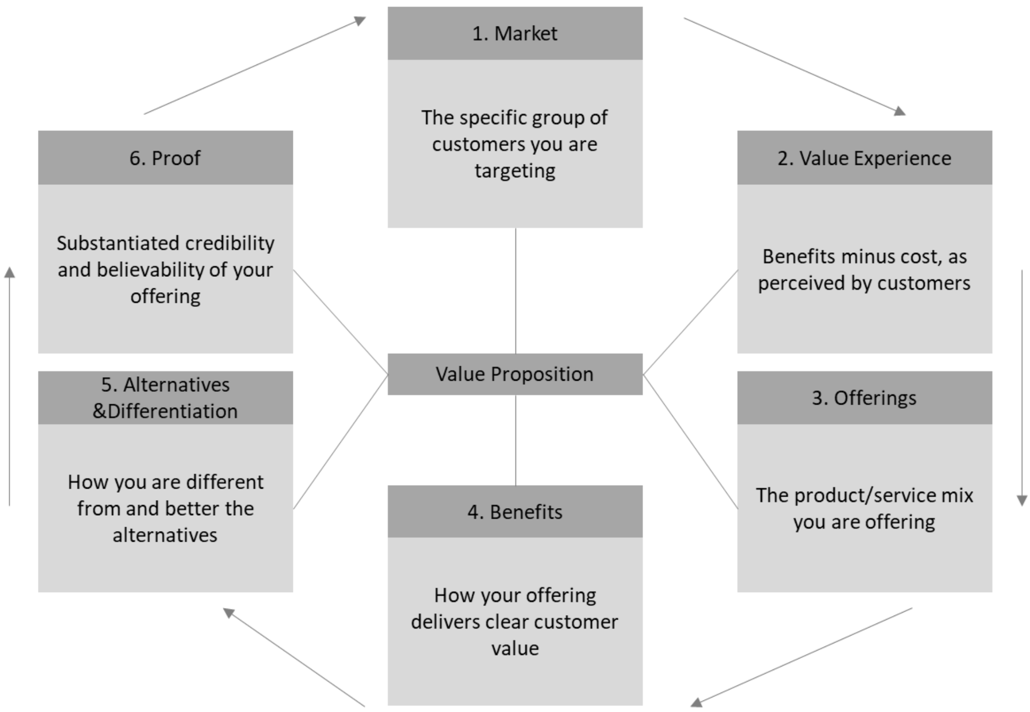
The value proposition concept was introduced by Lanning & Michaels (1988), writing that value propositions are echoed and communicated throughout business organizations in order to facilitate delivery of superior value to customers. It defines in essence the benefits received by a customer from a firm's offering. A company's value proposition is a critical element to an organization's business model as it provides how the business is relevant to its customers (Rogers, 2016). Moreover, the clarity of the value proposition is the single most important parameter of strategy for businesses, as it provides the dimension of how the firm is differentiated from competitors (Kaplan & Norton, 2004). Value proposition presents a novel way of thinking as it puts the customer as a key stakeholder compared to traditional shareholder focus (Barnes et al., 2009). Lately the concept is receiving increasing traction, propelled by today's rapidly changing business environment where the incumbent of today may be in decline tomorrow due to lost customer relevance. Osterwalder et al. (2014) provide perhaps the most commonly referred to illustration of the components of a value proposition in their value proposition canvas. Figure 2 shows the canvas, which has two main components, the value (proposition) map and the customer profile to the where the fit between them comprises a successful proposition.

Figure 2 - Value Proposition Canvas (Source: Strategyzer, 2018)



The value map describes the components of a particular value proposition in a business model in a detailed manner, breaking it down into products & services, pain relievers and gain creators (Osterwalder et al., 2014). Pain relievers denote how an organizations products and services relieve customer pains (e.g. poor outcomes, risks and obstacles related to customer jobs), and gain creators distinguishes how an organization's offering generates outcomes and benefits customers seek. The customer jobs concept is referring to what clients are trying to get done in their work and their lives, where an example could be to travel from point A to point B. Fit is achieved when customers are excited about the value proposition offered, i.e. when important customer jobs are addressed, severe pains are alleviated and key gains are created (ibid). Multiple frameworks exist to describe the concept, where Barnes et al. (2009) proposes a different framework to describe the concept called the Value proposition Builder. Figure 3 shows their proposed framework.

Figure 3 - Value Proposition Builder (Source: Barnes et al., 2009)



Barnes et al. (2009) framework has several similarities to Osterwalder et al.'s (2014) canvas. Both approaches stress an iterative process that is depending on multiple variables (e.g. different market segments, use cases and pains & gains) when generating value propositions, as there is rarely a 'one size fits all' type of offering any company can provide to all its clients. Moreover, the authors highlight the importance of being concrete and specific when utilizing the frameworks. In addition, central to the value proposition concept is the identification of the target customer, the offering and the benefits (i.e. solving customer job) of using said offering. Johnson et al. (2008) also centralizes these components into the concept, writing that the understanding of the customer job and its dimensions and the target segment facilitates accurate tailored offerings that achieve superior propositions.

It should be noted that value proposition is not the only concept viable to use when analyzing offerings and value to customers, but it has much utility since it includes multiple elements into its analysis (Rogers, 2016). Figure 4 shows how value proposition can be compared with other concepts when discussing market value for the automotive industry.

Figure 4 - Five Concepts of Market Value (Source: Rogers, 2016)

Five Concepts of Market Value

Concept	Concept pros and *cons (in italics)*	Examples as applied to automotive
Product	Important in portfolio decisions *Ignores customer and value to them* *Leads to strategic myopia*	SUV Sedan Minivan
Customer	Customer-centric Helps identify whom to focus on *Not focused on value*	College student drivers Parents with small kids
Use case	Value-centric and customer-centric Helps with better segmentation *Obscures that a customer may have multiple use cases*	Night out with friends Driving and carpooling with kids
Job to be done	Value-centric and customer-centric Helps identify nontraditional competitors *Lacks concrete specifics*	Safety and comfortably transport several kids from point A to B
Value Proposition	Value-centric and customer-centric Helps assess threats and ideate new innovation outside of existing products More concrete and specific (includes multiple elements)	Reliable transportation Accommodates several passengers Safety in an accident Personalization of car zones (e.g. for climate or audio) Communication for driver (e.g. hands-free calling Entertainment for passengers (e.g. Wi-Fi or video)

Comparing the value proposition canvas described by Osterwalder et al. (2014) to the other concepts, it can be seen that it includes multiple dimensions of market value, such as product, customer jobs and use cases. Rogers (2016) argues that value proposition's ability to comprise a value-centric and customer-centric view that includes multiple elements gives it a distinct usefulness compared to the other concepts when organizations face changing customer needs and opportunities caused by novel technology. As technology shifts show, in particular the advances in accessibility of ICT-technologies in recent decades, it becomes apparent that customer- and value-centric approaches are key to sustained competitiveness. Technology facilitates such an approach as, for example the internet, enables customers to attain information and rapidly switch providers to ones that has a customer focus and delivers superior value at lower cost (Barnes et al., 2009; Vandermerwe, 2000). Hence businesses that are not attentive to value propositions will likely see lower performance compared to competitors, which can lead to bankruptcy (Barnes et al., 2009). Rogers (2016) writes further that the digital age calls for businesses to constantly adapt their value propositions, as technology creates new consumer needs that are not bound by traditional boundaries. Figure 5 shows how this transition has changed the strategic assumptions for businesses.

Figure 5 - Changes in Strategic Assumptions from Analog to Digital (Source: Rogers, 2016)

Value: Changes in Strategic Assumptions from the Analog to the Digital Age

From	To
Value proposition defined by industry	Value proposition defined by changing customer needs
Execute your current value proposition	Uncover the next opportunity for customer value
Optimize your business model as long as possible	Evolve before you must, to stay ahead of the curve
Judge change by how it impacts your current business	Judge change by how it could create your next business
Market success allows for complacency	"Only the paranoid survive"

Hence, it can be stated that the concept constitutes major importance for any organization, and automakers are no exception to the rule. As this thesis argues, with the dawn of ML applications in businesses being here, there emerges novel product and service offerings, and thus new ways to generate gains and alleviate pains for customers. Autonomous vehicles and car connectivity powered by algorithms and data interlinked with changing customer needs can potentially spark generation of new value experiences that can challenge the current incumbent business model. Reviewing the value proposition as a component of an overarching business model through the canvas in figure 1, it becomes apparent that radically changed value propositions require extensive business model management.

2.3 Business Model Management

Sachsenhofer (2016) argues that in most large corporate organizations eventually develop different kind of business models for their different business units. Those Business models are split up in different elements. Now organizations will develop certain capabilities and competences in certain elements. They can use and leverage them in the business models of other business units. Sachsenhofer calls this strategy Business model Diversification. Furthermore, the Business models need to be considered in a larger context. Large organizations are closely intertwined and connected to their suppliers and customers, its ecosystem. In order to create the biggest value for the customer and hence for the company business models need to be adapted and tailored to their environment. Within his academic work leveraging business model components as drivers of business model portfolio, he describes 4 tools of handling business model.

Business model reconfiguration describes an assessment of the current Business model by an experienced manager within the changes of the environment that the organization acts upon in. Due to changes in the environment certain components of a business model become less valuable and need to be changed. In the context of the increased importance of AI the value proposition of the business models would need to be re-configured. If the reconfiguration of a Business model is radical, meaning that most components are new or that the value proposition is changed to a large degree one speaks of *Business model Innovation*. *Business model elimination* refers to the termination of the pursuit of a certain business model within a company. *Business model coordination* is the daily short-term adaption in business models. However, the elements of the Business model stay the same and no major changes are made. Business model coordination includes business process optimization, collaboration between functions and departments, internal benchmarking etc.

Further Ideas on Business model Innovation

In the framework of innovation, Business models display a complex construct, reaching out in two dimensions. First, a business model is a tool itself to promote, foster and manage innovation. A Business model defines a way an organizations delivers, realizes and captures it´s value (Dodgson et al., 2013). Therefore, if a company focuses on innovation to deliver value to the customer, the whole Business model will foster an organizational structure, culture and mentality that increase the level of creativity and innovation. Furthermore, a Business model itself presents a dimension of possible Innovation; Business model Innovation. By restructuring or innovating the Business model, organizations can significantly increase their delivered value to the customer. Similar to Sachsenhofer, Dodgson et al. (2013) also argue, that in terms of Business models and Business model Innovation, organizations must evaluate the network and ecosystem that they are acting in, as a basis for the restructuring. When managed accordingly, Business model Innovation increases an organization's opportunity exploitation in three different ways: First, if a new value proposition is introduced, the company can perform an addition task for the already existing customer segment. The life cycle of a product is usually coined by the following stages. When a product is introduced to the market, customer focus on functionality and that the product does its job. In the later stages, when the functionality is taken for granted customers focus more on quality and reliability. During this commoditization stage, usually process innovations are introduced to increase the products quality. However, Johnson argues, that Business model Innovation can increase customer satisfaction on a different level than process innovation; by creating a new value proposition that fulfills the individual customer needs better. Second, Business model Innovation can also push companies to target entirely new customer segments. Third, Business model Innovation can help companies to conquer entirely new industries.

2.4 Servitization

To review how the value proposition may be altered for the automotive industry by ML applications, it is useful to analyze what automakers actually sell to its clients, i.e. products and services. Car manufacturers have historically focused on selling their customers product ownership of the vehicle (Mahut et al., 2017), whereas in the later decades the adoption of servitization business models have become necessary to compete effectively in the 21st century (Baines & Lightfoot, 2013). Servitization refers to the evolution of manufacturing firms toward offering services (Vandermerwe & Rada, 1988), or can be defined as the transformation of manufacturing companies to increasingly offer services that are tightly coupled with their products (Baines et al., 2007). The rationale for servitization stems mainly along three factors; economic, consumer demand and competitive advantage (Oliva & Kallenberg, 2003). Economically, services can generate larger revenues to companies as they can be tied to products with a long life cycle (e.g. insurance for a car), generally have higher margins than manufactured goods and provide a more stable source of income as they show more resistance to economic downturns than products. Moreover, as services are less visible to competitors compared to products it creates basis for sustainable competitive advantage (Heskett et al., 1997). Bharadwaj & Varadarajan (1993) supports this view as long as the company is offering services demanded by the client, and that the tacit nature of services constitutes imitation barriers that provide sustainable competitive advantage, leading to better financial performance. It should be noted however that the distinction between products and services is more distinct compared to the reality of many businesses who rather use other parameters to evaluate their offerings. Baines & Lightfoot (2013) identifies that many manufacturer have a value proposition approach instead where they cater different offerings to customers' different propositions. Three such can be recognized by the manufacturers in their research:

1. Customers who want to do it themselves
2. Customers who want us to do it with them
3. Customers who want us to do it for them

Each form of proposition is named "base", "intermediate" and "advanced" services, corresponding to the level of services offered by the organization. Advanced services are interesting from a servitization point of view as it involves sophisticated bundling of products and services to meet critical customer needs (Baines & Lightfoot, 2013). The infamous power-by-the-hour model of Rolls Royce is an example of advanced service offering. Automakers have over time moved from base to advanced services revolved around the product, including maintenance services, guarantees, insurances and assistance solutions (Mahut et al., 2017). Baines & Lightfoot (2013) argues that for companies to effectively deliver advanced service offerings for an integrated experience it is key to align operations strategy to facilitate processes and structures that enable provision of such product-service offerings. Car manufacturers have over time set up such infrastructure through for example establishing dealership networks, subsidiaries and joint ventures to efficiently deliver these services. These services have thus far been focused on product-related services, with the underlying parameter for the car manufacturer that the customer possesses vehicle ownership.

With the onset of the rapid digitization of recent years this notion has been challenged by the evolution of new mobility solutions (i.e. leasing, renting, car-sharing) and the importance of software applications. Added services have thus also come to include more use- and result-oriented offerings, such as remote diagnostics and embedded entertainment enabled by car connectivity (Williams, 2007). Importantly, car connectivity facilitates automakers to provide supplementary services remotely, where software updates quickly can give the product enhanced features. Tesla Motors, a car manufacturer specialized on electric vehicles, is perhaps the most prominent example of this, as embedded software in the product can be updated over the air (Mahut et al., 2017). Prominently, automated driving features are such updates that Tesla is developing and distributing through car connectivity. It implies critically to automakers that technology allows remote digital transfer of novel service offerings. AD in itself is a service feature that could radically affect the service offering of a car manufacturer, as it is a use- and result-oriented service that facilitates for the end-user to not be the owner of the actual product. Digital startup companies such as Uber and Waymo (i.e. Google's autonomous vehicle subsidiary) seek to provide cars as a pure advanced service, where customers' proposition is that the company should provide the full service to them to deliver passengers and goods from point A to point B.

This presents a possible key shift in the nature of the value offering of automotive manufacturers, as technology is advancing the case for use- and result-oriented services offering vis-à-vis the predominant product-orientation industry paradigm. However it should be highlighted that such a transition is not a trivial matter, as it carries financial, strategic and operational implications (Ambroise et al., 2017). Further, such a move can entail a radical change of the manufacturer's business model, as providers of product-oriented services have business models mainly geared toward product sales and related services. On the other hand, service-centered views hold that "*tangible goods serve as appliances for service provision rather than ends themselves"* (Vargo & Lusch, 2004, pp. 13), implying operational models toward leasing, pooling and pay-per-use. Imposing such model changes can face opposition, as Oliva & Kallenberg (2003) rightly argues that manufacturers may be reluctant to implement new service offerings as they might not believe in the economic potential or decide that the services are outside of their core competencies. They also write that manufacturers may see the potential, but as they enter the market they fail at executing a successful service strategy. As an example Ford Motors attempt to enter the after-sales service market was blocked by its network of independent dealerships. Ambroise et al. (2017) elaborates that servitization strategies revolve around expanding into or reconfiguring the customer's activity chain, such as through the provision of advanced service offerings. In this light, it can be understood that with the increasing level of technologically complex automotive products and services that car manufacturers and other players in the industry will alter the way customers acquire, interact and consume such goods and services

2.5 Radical Innovation Management

Innovation can be described as a change to a business product, service or process that adds value (Rogers, 2016). Innovations can be categorized in radical and incremental innovations (Chiesa et al, 2009). The categorization criteria that are used to distinguish those two are the degree of newness and the difference from existing innovation and technologies. Radical innovations are characterized by a high degree of newness and a great difference from existing technologies. Incremental innovations usually show a low degree of newness and not so much difference from existing products (Schilling, 2013). Applying this framework on ML and AVs is important in order to determine the best innovation management strategy for the technology and identify possible hurdles. AVs display something entirely new to the market. Never in the history of humanity has non-human devices been able to learn and develop a certain degree of intelligence (Brynjolfsson & McAfee, 2017). Also, the technology, when fully developed, is radically difference from other technologies, simply because of the fact, that machines were not able to learn and possess intelligence before. Taking these two facts and apply them on the model states above, ML is clearly categorized as a radical innovation. Radical Innovation is usually connected with more risks for organization. The reason for the higher risk is mainly due to a higher degree of uncertainty. It is very complex to predict the response of the market to a completely novel and different product and hence the uncertainty of the success increases and therefore the risk.

Leifer et al. (2001) argue that radical innovations require different management practices compared to incremental innovations. The following will elaborate general innovation management decisions that have to be taken into consideration by managers and put them in the context of radical innovation. An important decision organizations have to take when it comes to manage innovation is the timing of market entrance. In the context of the timing of entrance organizations can be categorized into three fields: First movers, early followers and late entrants (Schilling 2013). First movers, are organizations that are pushing to the market early and are the ones realizing innovations and new technologies first. Early followers are following rather quickly the first movers, whereas late entrants are lagging behind. In the context of ML these concepts are of utter importance, since the implications of the timing of entrance have large effects on the outcome of the profits and benefits of the technology for organizations. The following will scrutinize first mover advantages and disadvantages to draw a picture of the conflict prevailing in organizations, when it comes to pushing innovations to the market

The first advantage first movers have is brand loyalty and technological leadership. Organizations, which bring something groundbreaking new to the market, are the ones having it developed fully first and hence are technological leaders in that field. Consumers, when satisfied with the product develop an affinity to the brand and the product and are likely to stick to it, when positively convinced. Another advantage of moving to the market first or at least planning to move to the market first is the preemption of scarce assets (ibid.). Scarce assets are usually human capital and, if the innovation is location dependent, areas to settle R&D centers, sales outlets etc. After some period of usage, some products create switching costs for the user. Switching costs refer to the costs implied on the user, if he wants to switch from one brand/technology to another. If a company makes use of first mover advantages and creates a large user base, there is a likely chance, that this user group gets locked in and will face switching costs (Castillo, 2012). Hence, there is a likeliness that this user group stays with the brand used before.

However, moving first not only has advantages. First movers, usually face high R&D expenses, since the technology needs to be fully developed and there are no knowledge spillovers available yet Furthermore, it is important to closely align Research and Development with Marketing, in order to guarantee market demand for the innovation (Chiese et al., 2009). Furthermore, supply and distribution channels might not be in place yet, which would make it impossible to push the technology to the market or connected with further financial efforts to establish those. Furthermore, it needs to be analyzed of complementary technologies are in place. Those complementary technologies either increase the value of the innovation or are a prerequisite for the technology. Lastly, when pushing to the market first, usually customer requirements towards a certain product are not precisely known. Some innovations are of outstanding new technology; however it can very well be that the customers do not demand for it and hence there will be a very small market penetration rate. This relates closely to the principle of technology push and market pull.

2.6 Radical Innovation and Collaborations

Innovations, especially radical innovations are often based on collaborations between different organizations. The reason for this is mainly the fact that products or services that are radically innovative are usually based on a large set of different capabilities that need to be juggled wisely to realize that end product. As well as moving to the market first, collaborations have both advantages and disadvantages. The main advantage of collaborations is, that a certain organization does not necessarily have to develop certain capabilities and competences but can tap into one of another organization (Schilling, 2013).

Another argument for collaborations between organizations in order to successfully manage innovation are complementaries. The concept of complimentaries is similar to the one of exchanging capabilities. However, in the context of complimentaries there is a mutual, a both-streak interest from the parties for collaboration, in contrast to the acquisition of capabilities of a firm (Dodgson, 2013). Some products are achieving the best results on the market when being hand-in-hand developed with another product, of another organization. A prime example for this is the co-evolution of Intel and Microsoft, working hand-in-hand to achieve maximum customer satisfaction, by Intel producing computers and Microsoft the operating system (Casadesus-Masanell et al., 2010). When managed thoroughly the collaborations between two complimentary companies can create significant synergy effects, meaning that profits for both companies are achieving greater results through the collaboration, compared to their isolated single performance.

3 The Automotive industry & AI – Contextual Framework

As this dissertation seeks to explore how the advent of AI technology, specifically ML, can affect the value proposition of automakers it becomes necessary to assess several factors, in order to comprehend the context of the technology and the industry. Osterwalder et al. (2014) rightly argues that value propositions and business models are always designed in a context subjected to market forces, technology and trends. Thus, in order to determine the value proposition of tomorrow it is required to overview the technology, its general capacities and limitations and the current trends affecting the automotive industry. The ensuing contextual framework serves as outlining to the researchers & the readers of this thesis the background and overview of AI-technologies and the changing automotive industry, in order to complement the literature review to establish the fundament from which the empirical findings are built on.

3.1 Definition of Artificial Intelligence and its categories

AI as a concept has been in the human mind for centuries, where philosophers and scientists have imagined machines to do task requiring intelligence (Buchanan, 2005). In the last half-century progress in the area has been propelled by the exponential increase in computing power, allowing machines to use complex algorithms and statistical methods to generate output from multivariate data input. Primarily used as a tool in the US military, AI was recognized to be a technology that could facilitate business decision-making as it could provide managers with information based on a large number of data sources in real time (Hong, 1983). Labeled as the most useful general-purpose technology of our era, AI technology is poised to have transformational impact in business on the scale of prior general purpose technologies (e.g. steam engine, electricity), and the results it has yet achieved is seen as a fraction of its potential (Brynjolfsson & McAfee, 2017).

Its greater relevance today is stemmed principally from recent advances under the label known as ML (Agrawal et al., 2017; Brynjolfsson & McAfee, 2017). ML is a software programming approach that vastly differs from prior approaches. It involves a practice of programming machines to learn from example data or past experience that leads to a desired outcome. In contrast, the previous mainstream approach for the past 50 years within information technology has been to codify existing knowledge and procedures and embedding them in machines (Brynjolfsson & McAfee, 2017). Forming the basis of the term "coding", this approach carries the inherent flaw in that most developers' and humans' knowledge is tacit, and is thus not easily transferred into code. ML is overcoming this hurdle as it learns from examples and using structured feedback to solve on their own problems. Developing ML programming commonly involves introducing it to a dataset of examples in a supervised learning system, oftentimes numbering in the thousands or millions, labelled as correct answers to a specific problem. Figure 6 manifests examples of supervised learning systems for ML.

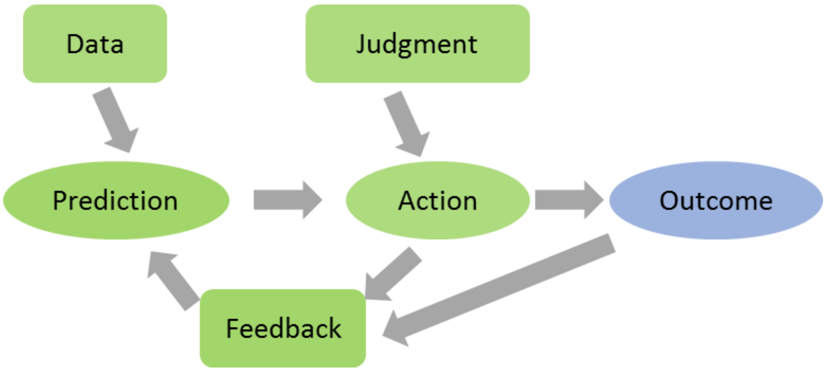
Figure 6 - Examples of Supervised Learning Systems (Source: Brynjolfsson & McAfee, 2017)

Input X	Output Y	Application
Voice recording	Transcript	Speech recognition
Historical Market Data	Future Market Data	Trading bots
Photograph	Caption	Image tagging
Drug chemical properties	Treatment efficacy	Pharma R&D
Store transaction details	Is the transaction fraudulent?	Fraud detection
Recipe ingredients	Customer reviews	Food recommendations
Purchase histories	Future purchase behavior	Customer retention
Car locations and speed	Traffic flow	Traffic lights
Faces	Names	Face recognition

In particular, many ML applications use an implementation technique called deep learning (Copeland, 2016). Deep learning software is an attempt to mimic the activity of layers of neurons in the human brain in an artificial neural network. It involves training the network to detect an object or phoneme by showing the software digitalized images or sounds containing them (Hof, 2015). Algorithms tune the network with training to enable precise calculations of probability to recognize objects and phonemes, facilitating recognition of patterns in large swathes of data in real time. The word "deep" revolves around the number of layers of neurons in the network, significant in number as the data used to train them is massive (Copeland, 2016).

Agrawal et al. (2017) writes that the key underlying benefit of ML is related to how tasks are conducted, as ML enables reduced cost of prediction in decision-making and adds prediction value by making use of large amounts of data. Figure 7 displays their definition of the anatomy of a task.

Figure 7 - The Anatomy of a Task (Agrawal et al., 2017)



As can be seen actions made when conducting a task is not an exclusive event but is shaped by underlying conditions, e.g. prediction and judgement. Prediction involves both anticipating future events but also predicting the present, such as when conducting a medical diagnosis which predicts presence of a particular disease. The cost of acquiring data and feedback from actions has significantly reduced in the past decades due to advances in computational and sensor power and data management, enabling ML-based predictions to be accessible and reliable (Agrawal et al., 2017). In particular, the usage of GPUs enables the computational power needed to execute deep learning software cost efficiently (Copeland, 2016). The value of prediction has too surged due to larger and more varied data availability than previously, which enables prediction methods to be conducted in a larger scope of tasks.

Hence, it can be claimed that the value ML brings to users is the enablement of machines to conduct specific tasks, thus creating new possibilities for novel products and services. Indeed, Davenport & Ronanki (2018) writes that companies implementing these technologies today have often performance enhancement in mind and providing employees with tools that adds or changes value added by the workforce. Coupled with Deloitte (2017) they write that AI principally can support three business needs: Process automation, Cognitive Insight and Cognitive Engagement. Process automation is the most common application, implying automation of physical and digital tasks. Cognitive insights implies using ML in order to detect patterns in large swathes of data, becoming increasingly capable over time and being further propelled by greater accessibility to different data formats that enables predictive &

prescriptive analytics impossible for a human peer (Kho, 2018). Engagement applications include for example intelligent personal assistants such as Amazon's Alexa or Apple's Siri, assisting in customer service inquiries.

Nevertheless, AI-based systems remain narrowed in scope of capabilities compared to human peers, as they are programmed to do specific tasks as they are yet unable to generalize and make abstract inference onto larger contexts (Agrawal et al, 2017; Brynjolfsson & McAfee, 2017; Davenport & Ronanki, 2018). It is important to note as there are many misconceptions about AI's capabilities, meaning it is key to stress that there is still a significant gap between the tasks a machine can do vis-à-vis a human, making executives rightly skeptical about its prowess (Ransbotham, 2017). AD vehicles comprise such a case where it yet needs to be seen that it can provide tasks on a level that is on par with human drivers.

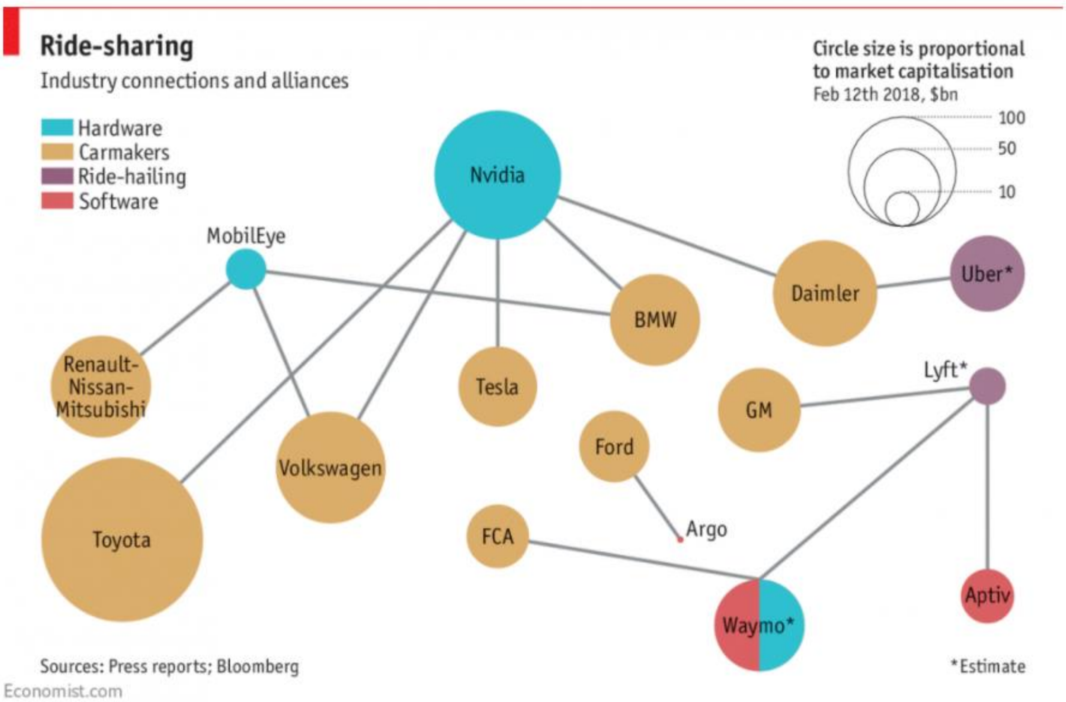
3.2 The Automotive Industry

The automotive industry is one of the world's largest, having a worldwide annual market value of $2 trillion and sales of 80m vehicles (The Economist, 2018a). As of 2015 1.1 billion cars were registered globally (Smith, 2016). An industry that has been growing markedly since the days of Henry Ford, the car automotive industry is at large continuing to operate with a 100-year old business model focused on car production, having core expertise in manufacturing excellence (Capgemini Consulting, 2015; The Economist, 2018a). Catering to virtually every market segment, from the exclusive to the mass market, the industry's different actors have multiple sets of value propositions to meet their clients' demands. However, fundamentally and universally it could be proposed that the industry's main propositions is that it offers products that provide reliable transportation for car owners, passengers and items in a relatively safe manner. In addition, further propositions include personalization, entertainment and in-vehicle utilities (Rogers, 2016).

Although, the industry is seeing according to many experts major disruption in the coming years, orchestrated by novel technology, shifting consumer demand, growth in emerging markets and sustainability policies that could potentially transform the industry (Scalise et al., 2018; Gray et al, 2017; McKinsey & Company, 2016; UBS, 2018). McKinsey&Company (2016) writes together with Stanford University that these forces along with new business models and digitization gives rise to four disruptive technology-driven trends for the automotive industry; AD, Car Connectivity, Electrification and Diverse Mobility. In particular, this paper focus is on AD based on ML technology. Self-driving vehicles has been labeled as constituting the most profound challenge to the car maker business model in a century (The Economist, 2018a), and has been named as the first major commercial application for autonomous technologies (Hempel, 2017).

In an industry that has traditionally been characterized by significant barriers to entry, autonomous technology revolves around several layers of different technologies constituting an eco-system including software and hardware that has altered preexisting barriers (Section 5.2.2. goes into the different technologies in more detail). This eco-system is subjected to a wide array of players that normally see their main business areas outside of the automotive, such as microprocessor producers such as Intel, Nvidia and Qualcomm; software giants Google and Microsoft and ridesharing companies Uber and Lyft (Kerry & Carsten, 2017). Additionally, startups such as nuTonomy and ArgoAI are playing an increasing role. It is also manifested by traditional automotive suppliers such as Delphi Automotive which recently acquired nuTonomy and rebranded the whole business as Aptiv, an autonomous vehicle company (The Economist, 2018c). Investments, acquisitions and partnerships in the area have been significant, numbering $80 billion in 2014-2017 (ibid). To give an illustration, figure 8 shows major industry connections and alliances in this growing eco-system (ibid).

Figure 8 - Industry Connections & Alliances in Ride-Sharing (Source: The Economist, 2018c)



In essence, as software and specific hardware components are becoming increasingly more important in the development and commercialization of automotive products it allows for entry into the industry by players who previously had businesses unrelated to cars, but are tempted by the potential gains of becoming a key stakeholder in the autonomous eco-system. Estimated to a value of $7 trillion by the year of 2050, the future global “passenger economy” (i.e. the economy of autonomous in combination with ride-hailing) is providing enticing business opportunities for automakers, suppliers and tech companies alike. Hence, for OEMs the industrial boundaries is becoming increasingly blurred and the new competitive landscape requires mastery of new technologies and strategies to deliver novel value to consumers.

4 Methodology

4.1 Research Strategy

The core goal of this thesis is to comprehend the ongoing and foreseeable trajectory of the phenomena of self-driving cars, and how its' advances can affect the industry's incumbents value proposition towards its customers. To reach the research objective the authors determined it is essential to study a multitude of accounts, theoretical and empirical, in order to construct a relatively externally valid picture of a future case. Studying key literature within the relevant domains of Value Proposition, Servitization & Business Model Innovation, and empirical data collection from primary and secondary sources reviewing the progress of autonomous cars and what their implications are for car manufacturers' business models, is combined for the purpose described above. It should be noted though, as the case for automated cars is ongoing and is largely affected by a significant number of factors, in a constantly changing environment, that the study topic is substantially dynamic which makes the case for an objective conclusion difficult to achieve, especially in a short time frame. Hence, this dissertation's research approach is based on the epistemology of interpretivism, implying that the researchers' interpret qualitative data in order to establish an understanding of certain circumstances compared to positivism that entails that observations gathered are facts, free from the researchers' subjectivity (Bryman & Bell, 2011). Moreover, the research strategy is embedded with the ontological concept of constructionism, as interview cases and other empirical findings picture a particular reality which may not be objective, but nevertheless serves as the basis for discussion of theory, conclusions and implications.

In the context of business research there are two main strategies how to conduct a study, either through a qualitative or quantitative approach (ibid). Qualitative research strategy is mainly used when the research question answers study inquiry's starting with "How" & "Why" compared to the quantitative approach which focuses on answering "What", since this is easier to quantify (Saunders et al., 2009). The ensuing study is using a qualitative research strategy. Yin (2009) proposes that "how" & "why" questions are aptly fit for studying contemporary events and behaviors, and are the most suitable to use for a multiple case study design.

4.2 Research Design

The thesis is located in the area of an exploratory research utilizing a multiple case study design. "Exploratory case studies tend to be conducted as preliminary research in advance of wide-scale surveys to map out the themes for the subsequent research" according to Bryman and Bell (2011). As a comprehensive impact of AV on the automotive industry cannot be precisely determined today, this framework is applied to the study. Furthermore, the evaluation on how Business models will shift according to the trends in the automotive industry and the gaining traction of AV is currently also rather vague. Hence, it also falls in the category of an exploratory study. A case study is an adequate research method to answer questions of how and why (Yin, 2009). Additionally, case studies can be either used inspirational or illustrational (Siggelkow, 2007). In case an inductive research approach is applied it is recommended to use case studies as inspiration to draw a theory from it.

Multiple case studies are used ideally to examine cross-case comparability in order to determine unique and similar themes in the different examination objectives. It can be distinguished whether findings are a unique occurring or whether they can be generalized (Saunders et al., 2009). Furthermore, triangulation is used by not only conducting interviews with experts from the automotive industry, but also secondary data sources such as industry reports and journals. Triangulation entails using more than one method of data sourcing (Bryman & Bell, 2011), with the goal of attaining a comprehensive view on the study area (Hastings, 2010). Hence, the following research examines the expert opinions of consultants, automotive suppliers and automotive manufacturers towards the gaining importance of AD within the automotive industry, representing varying perspectives. Thereby the level of validity within the research will be increased.

Following the thesis primary research question, the study's scope is set to cover future events, which requires generation of possible outcomes to predict the future, namely scenarios which can be defined as: *"Scenarios are archetypal descriptions of alternative images of the future, created from mental maps or models that reflect different perspectives on past, present and future developments."* (Greeuw et al., 2000, p.7). Scenario analysis subsequently is a process in which various industry developments are studied jointly with firms' ability to respond to these developments (Law, 2016). As this paper's focus is to discover a possible value proposition shift for car manufacturer's due to AV, the authors aim to explore the main possible outcomes by the end of the timeline in order to make the argument for how the value proposition can transition. Law (2016) writes that expert opinions are used in scenario analysis to formulate a qualitative view of the future in order to predict it, whereas the research is designed to facilitate triangulation of the findings from the interview cases with other views that can support generation of possible scenarios.

Multiple techniques exist within the scenario methodology spectrum, which often coincides with other instruments in other types of methodological designs such as trend analysis & actor analysis (Kosow & Gaßner, 2008). Kosow & Gaßner (2008) outline that the general process used comprises four phases: Scenario field identification, Key Factor identification, Key Factor Analysis and Scenario Generation. In this thesis, phase 1 is the dissertation's overall topic, the stage of AD by 2030. Phase 2 involves identification of key factors involved in its implementation, namely the hurdles that need to be overcome, derived from theoretical and qualitative inquiry. Phase 3 involves analysis of identified hurdles, which generates the scenarios in Phase 4 that are assessed on likelihoods of occurring according to gathered data.

Summarily, figure 9 outlines the thesis research design used to reach conclusions to the primary and secondary research questions.

Figure 9 - Thesis Research Design (Authors' Illustration)

4.3 Collection of Data

4.3.1 Selection of Cases

The principal selection criterion for selecting the interviewees for this study was that they had a concrete linkage with the defined research questions, as that connection is fundamental in order to specify which cases to approach and what data to collect (Eisenhardt, 1989). Yin (2018) further adds that each case in a multiple-case study design needs to be carefully selected so that they either predict similar results or predict contrasting results due to anticipatable reasons. The authors sought to include cases, i.e. experts of the automotive industry & AV that were providing varying perspectives on the research area, in order to both replicate similarities and contrasts that would correspond to the advantages of a multiple case study design. Ensuing, the researchers established the following criteria that had to be fulfilled by the cases in order to fit the thesis scope and generate relevant findings.

- The interviewee cases had to be employed in an organization that is connected to the automotive industry, such as an OEM, supplier, consultancy or academia
- The interviewee cases are working or have experience & knowledge of AI applications in the industry and AD in particular
- The respondents are affiliated with the areas of business development, innovation or product management in the automotive industry
- The case subjects had several years of work experience within the industry

After establishing the criteria the researchers reached out to organizations that were affiliated with the automotive industry, primarily OEMs and developers of ADAS (Advanced Driving Assistance System) & AD software. Contact was made through primarily email, phone and the social media platform Linkedin in order to find respondents. Approximately 20 identified potential respondents were contacted, resulting in five interviews with eight experts that fulfilled the criteria above, from different perspectives of the automotive industry, including an OEM, a consultancy, a car R&D company and an ADAS/AD software supplier. One of the interviewees was employed by an OEM of trucks, but was included as it was deemed as providing an alternate account of the studied phenomenon. The interviewees had different responsibilities within their respective organizations such as New Technology Manager, Product Planning Manager, Innovation Leader & Vice-President.

4.3.2 Primary Data

The primary data for the study are gathered through semi structured interviews. Those interviews are conducted in person or via telephone. To increase the validity of the study, the principle of triangulation is used. Opinions from different parties of the examined phenomenon are included in the interviewing process.

Semi structured interviews

In order to conduct a qualitative study, based on interviews, there are structured interviews, semi-structured interviews and unstructured interviews. This Master Thesis uses semi-structured interviews for its data gathering. Semi-structured interviews are non-standardized, in which the researcher has a list of themes and questions to be covered, although the questions can actually differ from interview to interview (Saunders et al., 2009). They can be seen as a mid-path between structured interviews, such as surveys and unstructured interviews like conversations (Bryman & Bell, 2011)

Semi-structured interviews are particularly helpful in the thorough scrutiny of a case. Bryman & Bell (2011) argue that in contrast structured interviews are not appropriate when the researchers are trying to find new ideas. Interviewees are encouraged over the unstructured interviews to elaborate and pursue their ideas freely. The interview process of the interviews was flexible. Hence the interviewer had the freedom to ask follow up questions or mix the order of pre-defined questions, in case this created a value and helps the interviewer to understand the topic at hand.

The interviews were conducted mostly at the office of the interviewees, ranging 30-60 minutes per occasion. One interview was made through Skype due to practicality reasons. Each interview was recorded using a smartphone which served as the basis for the transcription process. Transcribing the interviews was done by coding different discussed themes into distinct categories that served as a basis for the subsequent structure of the empirical findings.

When using semi-structured interviews for data acquisition an interview guide provides a basis for the interviewer when leading the interview. The reasoning is that the interview guide covers the main themes and topics that must be covered in the interview to ensure comparability over the different interviews (Bryman & Bell, 2011). However, the interview guide (See Appendix) only provides a rough outline of the interview and the researcher is allowed and even encouraged to break out of this guide to ask follow up questions. This is when the interviewer detects themes and areas of interest that require further investigation.

Collis & Hussey (2013) argue to conduct some fieldwork and literature review before creating the first draft of an interview guide. The interview guide in the framework of this Master thesis was established in the following order. First, both researchers carried out a thorough business literature review towards the topics Business model (Innovation), AI technology, Value Proposition & Servitization and trends in the automotive industry. This background knowledge was then mirrored against the two research questions. Themes and logical relationship between certain facts and their implications were drawn. The logics and connections between certain facts and their implications laid the basis for the first draft of the interview guide. Since the creation of the interview guide and the literature review were conducted simultaneously, the researchers reviewed and updated this interview guide regularly, to ensure the best possible adequacy for the research area.

To ensure cross-case comparability, the same interview guide was used for all interviewees. Bryman & Bell (2011) write that a certain degree of structure is necessary to allow comparison of cases in a multiple case study. As the researchers chose to utilize semi-structured interviews with many open questions rather than closed questions it was deemed that utilizing the same interview guide would facilitate the comparison between each case as the overarching themes discussed would be the same.

4.3.3 Secondary Data

Additionally to the primary data delivered through the expert interviews of automotive experts, from relevant areas, this study makes use of the status quo literature knowledge of the research topic. This extensive literature review was conducted to develop the theoretical framework, overarching the research questions. The two research questions are:

"How will the car manufacturers' value proposition be affected by automated vehicles enabled by machine learning technology until 2030?"

and

"What are the major hurdles to car manufacturers' implementation of automated vehicles?"

In order to ensure an adequate degree of feasibility of the literature review in terms of covering all relevant topics of the research questions, the literature review was conducted in a systematic way. All terms that are important in regard to the following analysis were examined and knowledge about them built up.

First, the overarching complex of the case study was examined, the automotive industry. The focus was hereby set on the trends that the automotive industry is undergoing right now in the near future. Furthermore, the current value proposition of the automotive industry was sketched to lay a basis for the change prediction. Second, the concept of value proposition in the framework of business models were reviewed, in order to give background information on how a value proposition works and how it can be changed. In terms of Business models, the focus was set on Business model Innovation, since one way of innovating Business models is changing its value proposition. In addition, the concepts of radical innovation management and servitization were worked out, in order to determine obstacles and implementation implications of autonomous cars. Since the thesis describes the impact of a particular category of AI technology on the automotive industry, a contextual framework was made. The authors elaborated on AI-technologies and their capabilities in combination with presenting a quick overview of how it changes the current industry structure, serving the purpose of giving the researchers an understanding of the underlying technology and its impact on the business context.

Further, secondary sources were used to complement the picture given by the expert interviewees in the empirical findings. The primary reason for using other accounts to answer the research questions was to increase external validity, as it is an industry-wide phenomenon which requires several points of view to generate findings that can be applied on the setting. In addition, industry reports, articles and journals can provide interesting and insightful dimensions that can facilitate understanding encountered concepts and topics during the interviews.

Inclusion & Exclusion criteria

The literature review & secondary research was done based on several different source categories. Textbooks were reviewed, scientific articles and articles from well-respected consultancies such as McKinsey&Company & Boston Consulting Group. Table 1 covers the criteria used.

Table 1 - Inclusion & Exclusion Criteria (Authors' Illustration)

Inclusion Criteria	Exclusion Criteria
• Sources covering the content of Business Models and Business Model Innovation • Sources sketching the concept and challenges of innovation management • Sources outlining the recent trends and predicted development of the automotive industry • Sources introducing AI generally and further specify its capability and application potential • Sources covering the value proposition concept and its relation to the business model • Sources covering servitization of manufacturing firms and its implications	• Sources explaining AI technologies in too great detail, such as on programming or algorithm dimensions • Sources that are not credible (e.g. questionable sources) • Articles or Books that have not been published, meaning they have not been approved by revision • Academic articles & journals that have not been peer reviewed

Searching Key Words

For the literature review the following key words that laid the basis for the literature search were applied. In order to get more detailed articles the keywords were sometimes connected or intertwined.

Business model, Business model Innovation, Value proposition, Innovation Management, Radical Innovation, Trends Automotive industry, Automotive industry management, AI, ML, AD, Servitization, Servitization Automotive, Self-driving cars, Digitization Automotive Industry

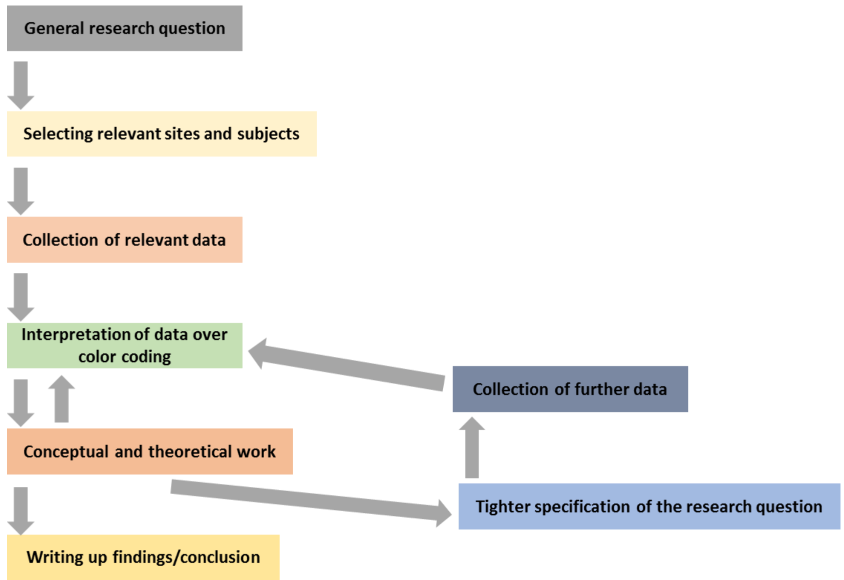
Databases and Libraries used

The only library that was used for this Master Thesis was the Library at the University of Gothenburg (GUNDA). Furthermore Databases were used to underline the research conducted. The databases were namely: Business Source Premier, EBSCO, Sage, Emerald and LIBRIS.

Research process

This thesis orientated itself towards the research process suggested for qualitative studies by Bryman & Bell (2011). The research scheme is sketched in figure 10.

Figure 10 - Research Process (Authors' Illustration)



First the researchers developed a general research question in their field of interest. In this case the first draft was “How will AI change and affect different industries”. After a superficial literature review the research question was narrowed down to following, more detailed research questions:

“How will the car manufacturers’ value proposition be affected by AV enabled by ML technology until 2030?”

“What are the major hurdles to car manufacturers’ implementation of AV?”

After having the precise research questions defined, an extensive literature review was conducted in order to have profound background knowledge of the overarching topics and create a knowledgeable fundament for the later analysis. Afterwards, expert interviews were conducted and the interviews transcribed and analyzed. For the analysis a color coding scheme was used. The different answers of the experts to the different questions were listed under the question itself. Afterwards the authors assigned colors to different themes of answers. Afterwards this coding was used to determine the commonalities and differences between the experts, laying the basis for the following analysis.

The detailed research process is illustrated below.

1. Definition of area of interest
2. Draft for research question
3. Literature research
4. Creation of research question possibilities
5. Choice of final research question
6. Literature review
7. Constant alignment of knowledge between research partners
8. Definition of methodology
9. Preparation of interview guide
10. Further literature review
11. Discussion of interview guide
12. Test interview
13. Interview
14. Interview transcription
15. Coding of themes

16. Analysis
17. Discussion of findings
18. Finalization of research

4.4 Research Quality

This study carries several drawbacks that affect the external validity and reliability of its results. Firstly and most prominently, as the research is aiming to reach conclusions regarding how a certain technology may change the value proposition of one of the world's largest industries in the future it is subjected to uncertainty to a significant degree. Predicting the future is challenging for any study as it forecasts outcomes of tomorrow based on research and assessed likelihoods of today, whereas unexpected events, trends or technologies may strongly affect the outcomes. To manifest it in a current illustration, during the research for this paper an autonomous vehicle conducting a test run in Arizona killed a pedestrian on a cross-walk, and forensic expert analysts concluded that a human driver may have avoided impact (Beene et al., 2018). Events such as these pertains the conceived value added by using ML technology in vehicles, highlighting that unforeseen circumstances may influence the course of the technologic trajectory and thus disprove or confirm the findings in this thesis.

Moreover, the results of this study may not reflect a comprehensive view of the factors involved and affected by the technology in the industry. The sample size of eight industry experts from different organizations within the field represents a small representation study group compared to the number of entities involved in the industry. Further, that most of the interviewees were of Swedish origin is a major drawback of the study as it leaves out a large number of possibly interesting interviewee subjects that could provide alternative perspectives on the topic at hand. It could have proved valuable to have included a quantitative study to contribute to a more statistically considerable analysis.

The authors sought to establish a consequential procedure when conducting the qualitative inquiry in order to promote the study's replicability for future research. However, as each interviewee carried different roles within their organizations and came from different professional backgrounds it becomes problematic to replicate a similar group of interview experts in an equally small sample. Yin (2018) rightly writes that case studies need to address the reliability concern that comes with the scarce opportunity of repeating a case study. In addition, due to the recent rise of relevance for the value proposition concept it was unclear whether the respondents had proficiency in the research concept or had greater expertise in related categories. Still, the interviewees were all involved in innovation, business development and product management, indicating individuals with insight into what particular value specific services and products provide to customers. Additionally, the researchers aimed to achieve external validity by selecting interview cases that could represent different points of view on the technology's capacities. The thesis did not focus on defining an optimal sample size, which stems mainly from practical reasons such as the limited timeframe and difficulty of finding interview subjects that fit the research criteria. This resulted in a constricted reach and ability of acquiring a quantitatively significant number of respondents. Hence, the interviewees' views do not represent the unilateral view of how the technology may affect the industry's value proposition, but rather how a differentiated group of experts believe how ML techniques may affect the future value provided by automakers.

Furthermore, as a multitude of scholars in business research methodologies argue (Bryman & Bell, 2011; Merriam & Tisdell, 2015), a drawback of qualitative research is that the researchers' subjective interpretations and views impact the study's analysis and conclusion. For instance, the semi-structured interviews formulated questions based on the researchers' theoretical findings, implying that the questions may have been designed in such a way to either confirm or disprove the researchers' interpretations of the theoretical framework. Consequentially, such a design can have had the implications of not giving the interviewees an unfettered chance to describe their viewpoints. However, it was deemed necessary for the study's analysis and conclusions to guide the semi-structured interviews in order to gather comparable findings.

Moreover, triangulation is oftentimes a concept referred to when discussing research quality. Triangulation entails that research is conducted utilizing several different methodologies and approached from multiple perspectives (Quinlan, 2011). Applying a combination of qualitative and quantitative approaches, or a series of observations and a focus group, constitute examples of triangulation where the goal is to attain a comprehensive view of the study topic by adhering to a multitude of perspectives (Hastings, 2010). In addition, further dimensions of a study area that would be difficult to explore using other methods may be discovered by utilizing triangulation in combination with a qualitative research design (Jick, 1979). For this thesis, the researchers chose to triangulate by applying theoretical concepts to a qualitative inquiry based on secondary research and through interviews with different actors within the automotive spectrum including an OEM, an ADAS/AD software developer, a car R&D company and an automotive consultancy. Moreover, the validity of the qualitative findings was strengthened by conducting a member check. Lincoln & Guba (1985) assesses that member checking as the most critical technique for establishing credibility in a study. It comprises of taking gathered data and interpretations back to the study participants in order for them to confirm the credibility of the information and narrative account (Creswell & Miller, 2000). Although, it is critical to highlight that triangulation has its limitations and that some scholars questions its importance (Hastings, 2010). Where some posit that it possibly provides a more nuanced view on the research area, others argue that its effectiveness relies on the presumption that the drawbacks of each methodological approach are compensated by the benefits of another approach (Jick, 1979). Therefore, as this thesis lacks a quantitative inquiry to complement the qualitative research approach it results in a triangulation that is not optimal.

5 Empirical Findings

The empirical findings are structured in the following manner. First is a presentation of the industry experts and the organizations they belong to. Thereafter the order is: AI, ML and AD as a Transformative Force in the Automotive Industry, Effects on Business model & Value proposition, New Competencies and Hurdles.

Each section is covering primarily the findings made from the expert interviews. They are subsequently followed by the empirical results made from secondary data sources. The sources used for the secondary findings hail from industry expert reports, academic journals, research publications and renowned magazines and news outlets.

5.1 Presentation of experts & their organizations

Table 2 gives an overview of the interviewees in this study.

Table 2 - Overview of Interviewees (Authors' Illustration)

Organization	Organization type	Working Title	Interviewee
Zenuity	AD/ADAS Developer	Business Developer	A
Zenuity	AD/ADAS Developer	New Technology Manager	B
CEVT	R&D in Cars	Product Planning Manager	C
Volvo Group	OEM (not of cars)	Innovation Leader	D
Volvo Cars	OEM	Senior Innovation Manager	E
Automotive Consultancy X	Consultancy	Vice-President	F
Automotive Consultancy X	Consultancy	Senior Consultant	G
Automotive Consultancy X	Consultancy	Consultant	H

Zenuity is a company that develops ADAS/AD software needed for autonomous cars. Their focus area lies on the initial part of the software chain, where the sensors feed the software with data. This interviewee provides insights from a Software company developing software solutions in the framework of AI for the car automotive industry.

Interviewee A is part of the Business Development team at Zenuity, being responsible for the strategic business orientation and how to meet the business target plans.

Interviewee B has been working in the automotive industry since 1985. Previously he has been working with passive safety and active safety systems in cars, stability control systems and automatic emergency breaking systems. Since 2009 his responsibility lies with self-driving cars with various different application categories.

CEVT is a Research and Development company designing Cars for Geely. AI and its impact on the car automotive industry is therefore of great importance for the company and it essential for CEVT to be aware of the latest trends in that field.

Interviewee C works within product strategy for CEVT. In this context he has further responsibility for long term strategic planning, based on long-term, industry-shaping trends.

Volvo Group is a truck manufacturing company focusing on B2B mobility services and products. Since, the processing of AI is also crucial for a truck manufacturing company on B2B level, valid insights can be gained in the frame of this Master Thesis.

Interviewee D is a senior innovation manager at a large truck manufacturing company in the Gothenburg area. His area of focus within the company is commercial transportation focusing on B2B commercialization. Within this framework the expert has worked with AI and ML for five years. Furthermore, he is responsible for strategy management in disruptive scenarios for the company.

Volvo Cars is Sweden largest car manufacturer and known for playing at the innovation frontier of the industry. As a car manufacturer, AI in the context of the automotive industry is of the outmost importance for Volvo Cars and credible insights of a car manufacturer can be gained from interviewing the company.

Interviewee E is a senior innovation manager at Volvo Cars. His educational background lies in engineering psychology. He is responsible for running and steering different innovation projects and developing innovation within Volvo Cars. Furthermore, he is responsible for university and start-up collaborations.

Automotive Consultancy X is a global management consultancy focusing on strategy, digital business transformation and implementation of digital technologies in organizations with a focus on Automotive, Retail and Financial Services industries. The interviewees had several years of work experience from projects conducted at OEM clients and pan-industry insights. The name of the firm is anonymized at the request of the interviewees.

Interviewee F is a Vice-President at Automotive Consultancy X. He has been in the industry for 12 years and the focus area of his consultancy work is the automotive industry.

Interviewee G is a senior management consultant at the consultancy and has been working on projects for a car manufacturer in both California and New York. Areas of focus were Connectivity and AD.

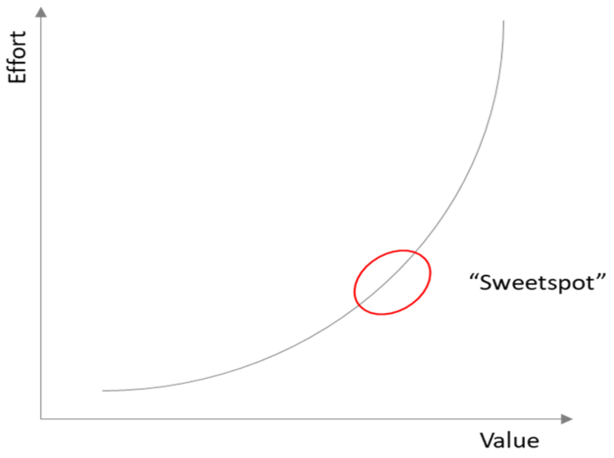
Interviewee H is a management consultant at the firm and his main focus area has been on consulting e-commerce platforms. Hence, he has profound knowledge of software management and data management.

5.2 AI and ML as a transformative force in the automotive industry

5.2.1 Primary data findings

Being questioned how AI will transform the car automotive industry, all interviewees draw connections between AI, specifically ML and AD. In all interviews the interviewees stressed that AD, to a certain level, will disrupt the car automotive industry. Ideas start to differ, when further pushed on how exactly it can disrupt the car automotive industry. Interviewee C, when asked how AI will transform the car automotive industry draws a very expressive draft, regarding effort and value of AD. Figure 11 illustrates the idea. Interviewee C drew a exponentially growing function of the effort against the value. The meaning of this graph's in terms of AD can be described with an example. Designing a car, that fully autonomously runs 100 meters straight and then stops, is not complex and is fully doable today and doesn't require much effort. However, the value to the customer would also go against zero. Now, on the other hand, fully AD in every situation requires real-time mapping of the environment, a finely adjusted set of sensors, a high performance computer on board of the car or in a computing tower, ML and a stable internet connection at all times so the ride is not getting interrupted. This poses the greatest value to the customer, but also drives up the costs for the company exponentially. In this context the interviewee mentioned what he called the sweetspot for car manufacturers. The sweetspot is the spot on the function, where the costs/the effort for the car manufacturers are standing in the best comparison to the value they deliver to the customer. This is based on the technology costs and capabilities but at the same time on the labor costs. Labor costs in this scenario describe, how much it would costs to let a human drive a car instead of having a machine doing it. Interviewee C says *"In China I have seen people cut grass with a nail scissor. If the labor costs are that low, you will consider employing a driver instead of an autonomous vehicle"*

Figure 11 - The "Sweetspot" Function (Source: Interviewee C)



It was repeatedly mentioned from several interviewees, that the question of the car ownership will affect, how much the car automotive industry will be disrupted. The sociocultural divergence in terms of car ownership between different markets can also affect the disruptive effect notes Interviewee C. In the less disruptive scenario, fully autonomous cars are on the market that the consumers still own. That would undoubtedly be a drastic change in the technology within the car automotive industry. However, consumers would still own their cars as they do it today and the customer- manufacturer relationship would stay the same. In a more disruptive scenario, autonomous cars are shared and their utilization increases. That scenario would most likely lead to the car manufacturers shifting their role into a mobility service provider. It could be possible, that the car manufacturers of today will be offering robo-taxi services tomorrow. Their profit model would switch from selling cars and making money on spare parts and maintenance to either a flat-rate service like “all you can ride” or a “pay-per-ride” service.

Lastly one interviewee mentioned, that AI can make the production and the development of cars much more effect, since over AI more knowledge can be gained what features the customer value in cars and over an increasing degree of automation the production can be smoothen and less costly.

The Case of Autonomous By 2030

In terms of answering the automation level available at the scenario timeline of 2030, the interviewees presented their opinions according to table 3. It should be mentioned that Interviewee B did not think SAE levels represent a good way of describing the automation level of a car, with the argument that SAE level 5 (SAE levels are explained in more detail in section 5.2.2.) implies that a car can drive in *any* condition, even those where it would be difficult or impossible for a human driver to operate the vehicle. Following that rationale, it was further stated that level 5 is more a vision rather than a tangible end result at this time.

Table 3 - Interviewees Answers for SAE Level 2030 (Authors' Illustration)

Expert	SAE Automation (L4/5)	Comment
Interviewee A, B	L4	L5 more vision than accomplishable goal
Interviewee C	L5	Geo-fenced areas for L5
Interviewee D	Cannot disclose	Mass market penetration needed for shift
Interviewee F	L5	Selected use-cases only, not ubiquitous
Interviewee E, F & G	L4	L5 solely used in particular use cases, where infrastructure is in place that supports it

Interviewee F, G & H state that the accelerating technology trajectory indicates that L4 can be achieved technically within the timeframe, however that societal barriers such as the issue of liability need to be overcome to pave the way for implementation. L5 on the other hand requires particular infrastructure to support it which will demand time before being accessible ubiquitously. Further, Interviewee G adds that the case for L4 is promoted by that drivers want to be able to delegate driving when they feel like it to retain the element of control over their vehicle, and importantly that L5 requires a minimum mass of vehicles in order to work efficiently.

Both interviewee C & G highlight that AD capabilities will likely by the year 2030 be available to both premium and mass market consumers. Interviewee G says that the amount of investment into the area purports that companies will want to diffuse the technologies through sales & licensing as quickly as possible in order to secure sufficient return on investment. In addition, the case for a robo-taxi service enabled by L5 will likely offer differentiation that will cater to different customer segments according to Interviewee C, targeting mass market & premium segments alike in 2030.

5.2.2 Secondary Research Findings

Conducting secondary research on the topic how AI will transform the car automotive industry, all the renowned management consultancies agree, that AI will affect the car manufacturing industry. The following passage comprises different opinions by different consultancies on the dimensions and degrees how AI will affect the car automotive industry. Roland Berger (Bernhart et al., 2014) argue that there are certain critical capabilities that a car manufacturer need to master in order to enable AD. One of these capabilities or competencies is a profound knowledge ML and deep learning. Striving in those technologies or acquiring them will enable car manufacturers to excel in AD. ML as part of AI, therefore sets the fundament of AD and affects the car automotive industry.

In the context of advancing AD the role of car ownership will change significantly. Currently car manufacturers sell the cars to the end customer who then owns it and uses it. In the future, that will most likely not be the case anymore. Short-term, the demand for car sharing and hailing services will increase. However, with AD advancing robotic cab services are predicted to come to the market, which would then replace the car sharing services. Such services are expected to come to the market a little further down the road, after 2030.

Furthermore, Roland Berger (Bernhart et al., 2016) draws the following picture regarding the car automotive industry within the framework of AI. The car automotive industry has always been an industry with high barriers to enter. Great amounts of tangible, intangible and human resources all need to be in place if a company wants to enter this industry. In the context of proceeding AD this is set to change. Apart from ML competencies AD also requires big data management, software management and real-time cloud capabilities. The classic capability spectrum of a car manufacturer does not include the above mentioned capabilities. Since the AD market promises billions in revenue, companies holding those capabilities want to tap into the market and more importantly they are able to do so, since their competencies will be required.

Lastly it is to say, that the transformation of the car automotive industry will not undergo a flying start. Car manufacturers need to work out new business models and their value proposition needs to be adapted. Capabilities in the above mentioned areas need to be exchanged and collaborations set up. Sensor technologies and data management need to advance. All those prerequisites for AD, point in the direction that the car automotive industry will undergo an incremental and slow change.

ML & Autonomous

Perhaps the greatest topic of all in terms of AI's possible impact on the automotive industry is its potential to allow cars to drive themselves. Originating in the DARPA (Defense Advanced

Research Projects Agency, the US military research agency) challenges in the period of 2004-2007, humans manifested for the first time the ability to let machines handle themselves sufficiently on fixed test tracks (The Economist, 2018b). AD can be defined as "*a motor vehicle that uses AI, sensors, and global positioning system coordinates to drive itself without the active intervention of a human operator*" (McKinsey&Company, 2014, pp 43). Essentially, ML algorithms are utilizing inputs from several different sources in order to enable the decision making process needed to drive the vehicle that would otherwise be done by a human driver (Bernhart et al., 2014). There exists extensive research coverage, journalistic hype and internet chatter on the topic (Shladover, 2017) which makes it key to see through the hubris in order to provide realistic assessment of how ML can facilitate introduction of self-driving features in motor vehicles.

Principally, it is necessary to recognize that the terminology AD is questionable as that it implies a complete replacement of human operator intervention. Steven Shladover, a Berkeley researcher who has worked in the field for 20 years (Simonite, 2016) writes that the discourse should rather be revolved around automation, as applications for automated vehicle technologies comes in different dimensions depending on the level of human interaction necessary to operate the vehicle (Shladover, 2017). The Society of Automobile Engineers (SAE) have outlined a universally used framework for automation levels, with levels 1 through 5, classified as driver assistance (level 1), partial automation (level 2), conditional automation (level 3), high automation (level 4) and full automation (level 5) (NHTSA, 2018). Table 4 outlines example systems and the role of the driver at each respective level. The term used to label these automation systems is Advanced Driver-Assistance Systems (ADAS).

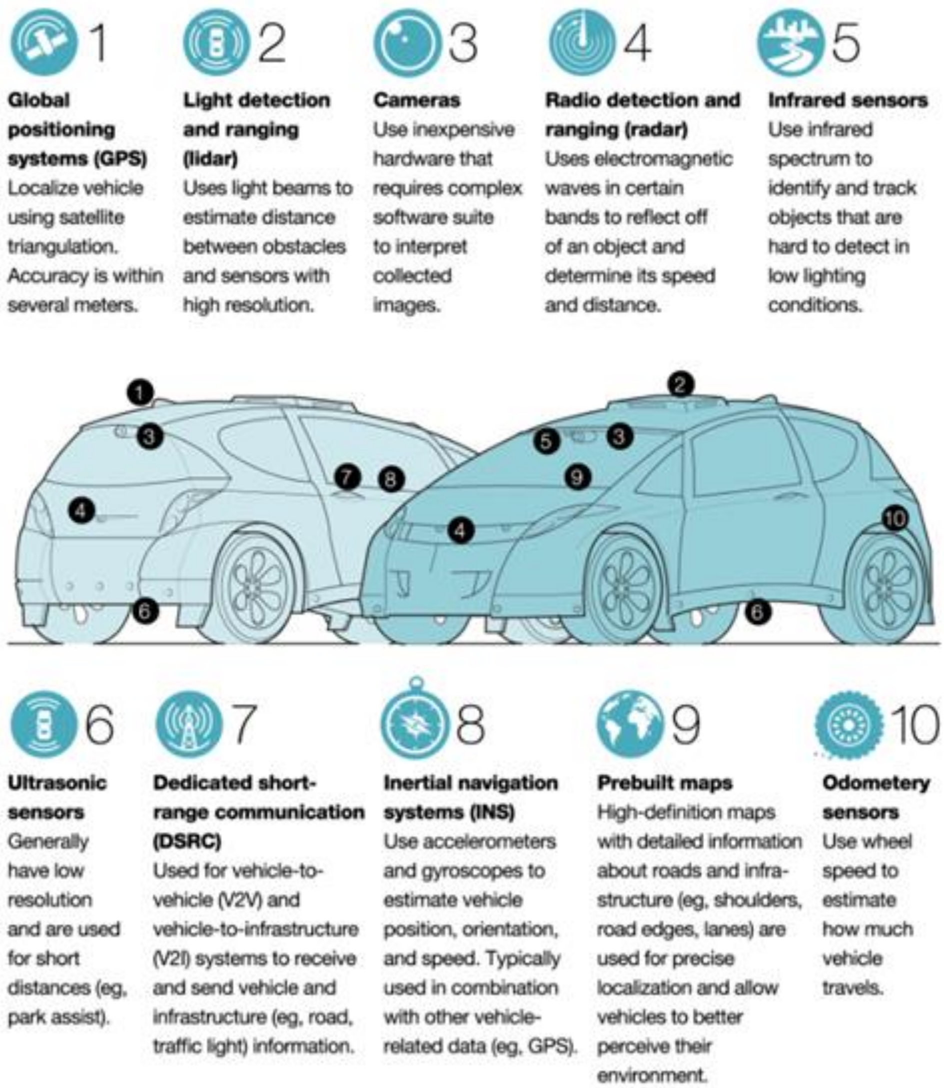
Table 4 - SAE Levels & Example Systems (Source: Shladover, 2017)

Level	Example systems	Driver roles
1	Adaptive cruise control or lane keeping assistance	Must drive *other* function and monitor driving environment
2	Adaptive cruise control and lane keeping assistance Traffic jam assist for freeway (Mercedes, Tesla, Infiniti, Volvo, etc.) Parking with external supervision	Must monitor driving environment (system nags driver or deactivates itself to try to ensure this)
3	Traffic jam pilot	May read a book, text, or web surf, but be prepared to intervene when needed
4	Highway driving pilot Closed campus "driverless" shuttle "Driverless" valet parking in garage	May sleep, and system can revert to minimum risk condition if needed
5	Ubiquitous automated taxi Ubiquitous car-share repositioning system	Can operate with no driver

As of 2018 up to level 3 has been achieved in a commercially available vehicle (the 2018 edition of the Audi A8). Both level 1 and 2 deliver driving comfort and convenience to the human operator. However they also require the driver to monitor the environment for hazards and be alert to take control of the automobile at all times, as situations can occur which the automobile cannot solve on its own. This naturally carries large risks of the driver "tuning out" and doing other activities whilst in the vehicle which can create dangerous and potentially fatal situations (Blanco et al., 2015). Automakers and other players involved in automation features have implemented different systems that warn or force the driver to interact with the car as it uses ADAS to operate on the road. However Shladover (2017) writes that it is uncertain whether or not it is possible to design a driver-vehicle interface that can successfully manage the transitions between human and machine to prevent accidents up to level 3.

To reach higher levels of automation is a technological challenge that stems mainly in the tasks the automated systems must solve. The Economist (2018b) writes that fully AV (i.e. SAE level 5) need to conduct three tasks: perception of surroundings, prediction of what will happen next and driving the car. The principal challenge lies in the perception, resulted from that the vehicle needs to compile and correctly label data entries in a matter of seconds to enable the machine to take the right action. MIT Technology Review (2017) writes that apart from ML algorithms for decision making that automated cars will employ a combination of sensors, cameras, radar, high performance GPS and LIDAR (Light Detection and Ranging) systems to perceive its environment. Heineke et al. (2017a) outlines an overview of sensor technologies involved (Figure 12).

Figure 12 - Overview of Sensor Technologies in AD (Source: Heineke et al., 2017a)



Visualized in the figure, a fully automated vehicle is operating through a technological eco-system with many layers. As human lives and safety are at stake AV require reliability and ability to adapt to diverse contexts (Kerry & Karsten, 2017). In particular, the many different technologies are used simultaneously due to that software carries a significant disadvantage in understanding the world. Computers can react much faster than human operators, however to identify and understand objects and situations, such as debris on the road or a traffic police gesturing, are things software struggles to achieve on human levels (Simonite, 2016; The Economist, 2018b). To handle out-of-the-ordinary situations is something machines are not good at, particularly due to limited capacity of abstract inference and lack of previously similar instances which teaches the software how to respond. Apart from sensor inputs it also uses connectivity to communicate with its surroundings vehicle-to-vehicle and vehicle-to-everything (V2V & V2X) in order to operate. V2V connectivity can for instance enable cooperative collision mitigation and cooperative adaptive cruise control, in essence strongly augmenting the capabilities of the onboard sensors (Shladover, 2017).

Furthermore, car connectivity is key to facilitate collection, management and analytics of the large quantities of sensor data, which is essential to improve the performance and reliability of AV (MIT Technology Review, 2017). Known as 'fleet learning', car connectivity allows vehicles to share their newly acquired knowledge to other vehicles of experiences on the road (Hsu, 2017). Imperatively, car connectivity is essential as sensor inputs are compared to 3D-modelled maps of the surrounding area in order to perceive it (Bradshaw, 2017), where the maps needs to be continuously updated. That being said, converting the data gathered from driven miles into labeled useful data for supervised learning systems that train ML software is a challenging task. Companies such as Mighty.ai tap into a community of hundreds of thousands that label images such as street signs and pedestrians (The Economist, 2018b). Startups such as Plus.ai and Drive.ai are developing deep learning software with the intention of alleviating the need for human input, as a part of AI-researchers' goal of achieving unsupervised learning systems (Bradshaw, 2017). Skeptics argue however that the need for human input will remain needed, pointing toward current difficulties of Facebook, Youtube and Twitter using deep learning to remove harmful content from social media without human configuration (Shaban, 2017)

In addition, the operational design domain (ODD) where AV can operate is connected to the automation level. Several sources write that (Heineke et al. 2017a; Simonite, 2016; Shladover, 2017) it is highly likely that AV operating at level 4 and above will first be seen in confined areas, thoroughly mapped and tested by pilot vehicles. Today many players are testing their automation pilots in particular areas where weather conditions are favorable to sensor technologies, such as in Arizona where both Uber and Waymo conduct tests.

Ultimately, ML is a key technology needed to achieve automated driving vehicles. Cornet et al. (2017) write that it is the technological foundation to in the future enable automobiles to operate autonomously. The time estimated when AV will be introduced to the market is largely under debate. Table 5 shows the forecasted time for L4 and L5 respectively, estimated by a selected group of renowned management consultancies.

Table 5 - Timeline for SAE L4/L5 (Sources: Heineke et al., 2017a; McKinsey&Company, 2016; Römer et al., 2016; Bernhart et al., 2014; Bernhart et al., 2016; Scalise et al., 2018, Mosquet et al., 2015)

Professional Service Firm	SAE Automation (L4)	SAE Automation (L5)	Restrictions
McKinsey&Company	2020-2025	2025(+)	Cannot operate in unmapped areas
AT Kearney	2020-2025	2025	Operation in metropolitan areas and most use cases
Roland Berger	2018-2020	2020	Low speed prior to 2025 (L5)
Bain&Company	2018-2020	2020-2025	Cities
Boston Consulting Group	2020-2022	2025	Not defined

5.3 Effects on the Business model and Value proposition

5.3.1 Primary Research Finding

On the questioned on how the Business models of the car OEMs when ML will advance and AD will be possible, all interviewees agree, that the Business model will change towards servitization. This assumption is based on the likeliness of AD advancing to a state where a car that drives autonomously is extremely safe and not too costly. Based on those assumptions in place further thoughts on how the business models will develop were the following. The shift from the traditional Business model/Value proposition to a more servitization oriented one, will not come within a day. Interviewee A, among other interviewees stresses, that car manufacturers will apply different Business models over some period; one traditional and one futuristic. *"I am convinced car OEMs will need to run double Business models over some time"*. The question of car ownership plays an essential role of the double business models that a company has to apply. Owning a car is of different importance for different nations and generations. Also the need for owning a car differs from city to rural areas. The servitization scenario will most likely be applied in areas, where there is a lot of data available for the maps and ML required for AD. In areas, where not many cars drive, data, that the ML computer uses will be scarce and hence AD might be hard to establish there. Interviewee D stresses, that the value proposition will build itself up around the customer demand. Interviewee D states *"People just want to get from point A to point B, no matter whether it's a* *bus or Uber taxi."* If customers in the future focus on "the job to be done" part, which implies, that they do not mind how they get from A to be B, that would change the value proposition in a different way, than the scenario that a customer still wants to be transported by a certain brand. *"The value chain will be built more around the customer's perspective rather than around the manufacturers perspective"*. Interviewee E further highlights that autonomous vehicles will free up substantial amount of time for passengers to pursue other activities whilst in the car. In addition, he adds the interesting possibility of peer-to-peer (P2P) emerging with the rise of autonomous, saying that it could enable consumers to let other users utilize their vehicles.

Furthermore a servitization business model will impose several challenges says Interviewee F. Car automotive companies right now sell their products to the customer and increase their monetary assets in their balance sheet. It leads to increased liquidity of the company, which in general gives great flexibility for economic changes, investments or making acquisitions. Providing a mobility service, would lead the car manufacturers to still owning the cars and having them as assets on their balance sheet. This would decrease their flexibility significantly and would make the car manufacturers sluggish in their decision making. Those factors need to be considered when adapting a business model in the context of progressing AI.

5.3.2 Secondary Research Finding

Having established the disruptive effect of AI on the car automotive industry, the following passage will examine how this change will affect the car manufacturers in terms of Business models. In order to manage the transformation around AI efficiently, car manufacturers need to ensure flexibility within their Business models. With fully autonomous vehicles coming to the market it is important for the OEMs to be early adopters, offering novel mobility services to customers. Pay-per-use mobility services or bundling AD features with other connected services are expected to be provided by OEMs. (Bernhart et al., 2014). Hence car manufacturers will have to the business model from solely car manufacturers to mobility service providers. The shift will be incremental and double business models at a certain time are not excludable (Heineke et al., 2017).

AT Kearney (Römer et al., 2016) argues that different segments of the car industry will be face different challenges to overcome in their business model innovation strategy. Luxury brands and the premium sector will maintain its' technological and design leadership, by having the strongest cooperations. Their business models will stay proportionally unaffected, since they will keep offering their luxury cars to their customers, with AD. The low-costs sector can compete by developing inexpensive autonomous vehicles or outsourcing their efficient production platforms to companies, which need those competencies. Becoming a service mobility provider or a manufacturing provider for other firms will rather drastically change the business models of the low cost segment. According to AT Kearney (Römer et al., 2016) the most dramatically affected are the companies serving the middle-class sector, as their product will lose their emotional appeal and a collapse in demand is likely. Lastly it is to state, that the possible Business model changes car manufacturers are undergoing have highly different outcomes in terms of revenue development. McKinsey (Heineke et al., 2017) states, that depending on how AD advances revenue variation up to 40% are possible. Inevitably car manufacturers need to be flexible on to adapt their business models, depending on how AD advances.

5.4 New Competencies Needed by OEMs

5.4.1 Primary data

When examining supporting competencies and technologies that the car manufacturer need to drive or improve, Connectivity was the one the researchers put the most focus on. Reason is car connectivity, mobile internet and cloud services are most likely going to be essential for car manufacturers when offering a mobility-as-a-service Business model. Autonomous Vehicles would either have their computing power, the underlying power on board or in a computing center. For this Connectivity must flawless to ensure constant computing abilities. Over applications on the mobile phone, customers could book mobility services. Therefore, cloud management and data management need to be in place.

However, over the different interviews it became clear, that the opinions on Connectivity differ. Interviewee B states, *"If you build AD on 5G you shoot yourself in your own foot. Connectivity draws too much attention in the context of AD".* Interviewee C explicitly states, that Connectivity needs to be improved *"You can't do it on 4G".* To complete the differing opinions Interviewee D states, that *"Connectivity is in a fairly good position for AD".*

Despite of having different options on the status quo of Connectivity, all interviewees agree on, that car manufacturers are keeping their ears and eyes open about companies possessing Connectivity, data management and cloud competencies. Strategic alliances and joint ventures are formed to ensure that the bundle of competencies that is needed to make AD happen is in possession of the car manufacturers. Smaller companies, that offer technologies that might be of the slightest interest, are often directly bought by large car OEMs. Different technologies such as Radar, Lidar, sensors, cameras etc. can be used to enable AD. Large companies do not want to miss out on any potential technology that could be of possible interest for them. Interviewee C says *"All the OEMs are buying those small companies like crazy. If they only have an idea they just buy because they want to own it. All the OEMs are so nervous on being the last on that race so they ain't taking any chances".* Interviewee C also underlined that internal development will likely constitute great importance when it comes to acquiring right skillsets and technologies for OEMs. He illustrates an example of how Ford Motor's recently changed its CEO to the former head of an AD technology subsidiary, largely indicating the importance for OEMs to drive change toward AD by having executive managers with backgrounds from these areas.

5.4.2 Secondary Research

Significantly, the development of AV along with other technology driven trends mentioned prior in this paper (McKinsey&Company, 2016) highlights the current gap of capabilities of most OEMs with the desired capacities needed to effectively appropriate the gains of ML technology. Beiker et al. (2016) posit that these trends push automobiles to evolve into computers on wheels, largely enabled by new advances in the software space. Illustratively, after 130 years of manufacturing hardware, Johann Jungwirth, CDO of Volkswagen, says: "*we need to take software and services just as seriously."*(The Economist, 2018a). Particularly in the race for autonomous it is noticeable that automakers are lacking a disadvantage compared to tech players who have a stronger capabilities in the software space of ML algorithms, managing data and cloud infrastructure (Beiker et al., 2016). Especially, as the nature of interaction between the OEM and customer may change with new business models (e.g. mobility services) from one-time transactions to subscription models it becomes important to have the necessary technological infrastructure that supports management of customer data to provide personalized services. Reviewing the activity of several OEMs (Bughin et al., 2017; Kerry & Carsten, 2017; Cornet et al., 2017; The Economist, 2018c) it becomes apparent that automakers are investing in acquiring and partnering with suppliers, startups and tech companies in order to attain capabilities in these fields.

5.5 Hurdles for Automakers

5.5.1 Primary data findings

The interviews that were conducted delivered a great variety of output in terms of what hurdles exist for car manufacturers to implement AI and hence AD and what implications can be drawn for them.

The first hurdle is of financial manner. Currently the *costs* for the different technologies, such as sensors, especially LIDAR are extremely costly and it would drive up the costs for an autonomous vehicle enormously. However most of the interviewees were of the opinions, that there will be a commoditization of those technologies, making them applicable for AD, not only in the premium models of the industry.

The next hurdle to overcome would be the *legislation and certification* of AD. Interviewee C outlines, that most of the AD legislations are locally governed. That has several implications for car manufacturers. First, it can potentially limit the testing scope and data collecting abilities of companies. Interviewee C indicates, that testing permissions are most likely handed to reliable local firms and not to potentially unreliable foreign ones. This poses several follow up implications. Given the fact, that the German car manufacturers are gathering data on German roads, US manufacturers on American roads and Chinese manufacturers on Chinese roads, this will most likely lead to the different manufacturers serving their local markets with autonomous cars. The second hurdle in terms of legislation and certification is the fact of ensuring safety. *"Safety is by far the biggest hurdle to overcome",* states interviewee B. In terms of safety the state of the art of the technologies is according to interviewee C the main measurement. This can be explained best with an example. As mentioned before, LIDAR is an expensive technology, giving a 3D visualization of the surrounding of the cars. This technology certainly can be applied within the concept of AD. However, it might also be possible to create autonomously driving cars without LIDAR. At his point, it needs to be underlined, that this example is just for illustration purposes and gives no valuation towards the different technologies. Now a company designs a car that drives autonomously without LIDAR and brings the product to the market. A person gets run over by that car and a commission examines the reasons for the accident. Now, according to interviewee C it poses a problem for the firm that they had not installed the latest technology in their car and questions will be raised whether the accident could have been avoided using the state of the art technologies.

Another aspect in the framework of legislation and certification is safety. Safety can be ensured by feeding enough data to the computer, the machine that learns. However, this turns out to be a major hurdle, since there are basically infinite amount of different situations and scenarios happening on roads. So, in short, the sheer and overwhelming amount of data to be gathered and fed to the system in order to reach human-close safety is the main issue. Interviewee B pictures the following scenario. *“If the Vikings wanted to develop autonomous sailing ships, they needed to sail the oceans for 500 years to gather the necessary data. Then the use case would not be adequate anymore.”* This theory is supported by the experience of Interviewee G, who states that “*Someone developed an application recording your driving and saving it in a cloud. You can turn it on when you ride your car and have your mobile phone locked in towards the street The guy sold the data to Daimler for around 17 million USD”.*

Taking the state of the art aspect and the data gathering aspect together, it becomes clear, that this is indeed one of the biggest hurdles. Car manufacturers need to first acquire enough data to feed their current models in order to make them safe. However, if within the years of actively developing a safe autonomously driving car, a new and more promising technology comes on the market that might ensure a higher degree of safety; the old model will not stand the legislation anymore.

Even having ensured the highest degree of possible safety creates the next challenges for companies. Building up customer trust. All interviewees were agreeing on that customer trust need to be gained by car manufacturers offering autonomously driving cars. This is a complex task too. Trust is a concept that builds upon experience. If you have driven a Mercedes for 10 years and experienced its quality in different situations, then you most likely trust that car. Since AD, when it comes to the market, will be a technology mankind has never seen before, experience is scarce, even for the car manufacturers themselves. Ideas to overcome such a trust issues are that companies detect how many accidents an autonomous car generates compared to human drivers. If that threshold is significantly lower one might argue that it can be proven to the customer that AD is safe.

According to the interviewees from Automotive Consultancy X safety is however not the only open issue car manufacturers face, even if they are able to design a reasonably safe car. *“... and then there is the ethical aspect. In case of an inevitable accident. Shall the car run over the woman with the small baby or the grandma on the sidewalk with her stroller?”.*

According to Interviewee G, market research is conducted in this area over a webpage, over which people are put in accident situations and have to decide who to run over in some milliseconds.

The last implication drawn from the interviews is for car manufacturers to be *quick and open for strategic alliances, joint ventures and acquisitions*. As stated before over acquisitions and alliances car manufacturers can gain competencies, that they would have otherwise needed to develop in house and thereby can save time and efforts. All interviewees however drew collaboration on a larger scale. In case AD is advancing and robo-taxi-services possible, the car manufacturers significantly lack the software and data management skills. Skills companies such as Uber, Google or Alphabet not only possess, but leverage them in order to get a piece of the pie of the enormous AD revenue stream that is about to come. Opinions on whether the robo-taxi-service will be managed by one of the before mentioned companies or whether car manufacturers try to gain those competencies and manage them themselves, differ.

5.5.2 Secondary Research

The challenges for OEMs are numerous in terms of appropriating and successfully utilizing ML applications in their businesses. In essence, the application of such technology in a mobility environment is on a level of complexity that requires novel structures around the mobility ecosystem (Cornet et al., 2017). New business models where automakers can move to become providers of mobility services (Heineke et al., 2017b) and use machine-learning systems that are both embedded in the car and the cloud are affected by different constraints. Cornet et al. (2017) writes that three key challenges exist: technological, regulatory and business models.

Technological aspects are originating firstly from current hardware, software and connection constraints. Shladover (2017) writes that the key technological challenges comprise:

- Developing comprehensive and reliable environment perception capabilities to be used under the full range of environmental conditions under which the vehicle is intended to operate (i.e. weather and lightning conditions)
- Providing the automated driving system with comprehensive fault detection that can rapidly diagnose its own malfunctions and switch to fallback mode that can maintain safety
- Ensuring sufficient cybersecurity protection

- Resolving questions of “robot ethic”, enabling system software to make life or death decisions that impacts the safety of all road users

And most importantly

- Designing software systems for a level of safety so that the rate of error in the system requirements, specifications and coding is sufficiently low that the system will be no less safe than human driving

Heineke et al. (2017a) further adds that the challenge to enable operation of level 4 and 5 vehicles in unrestricted terrain will require significant efforts from developers to overcome, as the number of use cases increases exponentially due to unconventional situations (e.g. unpaved roads, absence of lane markings). Additionally, they write that hardware capabilities are rapidly approaching levels needed for optimized automation technology, and that innovations will deliver the required computational power and cut prices. An example is the case of LIDAR equipment, which used to cost $70 000 per unit but companies now develop models costing a few hundred dollars (Gray et al., 2017). Software is the core bottleneck, as object analysis, decision-making systems and fail-safe mechanisms are key hurdles to overcome (Heineke et al., 2017a).

To emancipate AV to operate without human intervention and to prove that they statistically can match human peers in terms of error rate, the algorithms are trained through continuous driving to rack up driven miles. It is one of the yardsticks by which progress is measured in the quest for AD (Bradshaw, 2017). To accumulate miles is a paramount challenge to developers of AV, chiefly due to the sheer number of miles that needs to be accumulated to make proof of concept. Kalra & Paddock (2016) assess that 275 million miles needs to be driven *failure-free* to manifest that they have a fatality rate of 1.09 fatalities per 100 million miles with a 95 % confidence level, which is the fatality rate on US roads in 2013. That implies that a fleet of 100 autonomous vehicles being tested 24 hours a day, 365 days a year at an average speed of 25 mph would take 12.5 years to meet the benchmark without any accidents. To demonstrate the true failure rate to a particular precision degree and to manifest that AV have statistically significantly lower failure rate than human operators the same fleet of cars would have to travel for hundreds of years. Solutions to this significant obstacle could be the combination of real world testing with simulations, which can notably reduce the number of needed miles driven (Heineke et al., 2017a).

Overcoming the proof of concept and ensuring the safety and accuracy of ML systems in automotive is key to convince lawmakers and consumers alike of the prowess of AV. Cornet et al. (2017) write that regulators and legislation constitute a main challenge in several ways. Primarily, regulators have yet to define what the safety standards should be, say if it needs to correspond to human levels or go beyond (Hsu, 2017). Furthermore is also to note that traffic and infrastructure regulations and circumstances differ by regions and even cities. In addition, authorities have to better understand the technologies involved as regulation have to play catch-up with the advancements in automated driving (Shladover, 2017). Moreover, issues of liability in cases of accident will have to be resolved, as operator versus vehicle responsibilities will come under the legal lens (Römer et al., 2016).

Finally, the last challenge revolves around business model changes for OEMs. New models will emerge related to higher automation levels which may push automakers businesses toward B2B relations for example through fleet sales (Cornet et al., 2017) and to MaaS (mobility as a service) models. Ambadipudi et al. (2017) outlines that AV enables new use cases based on what the automobiles transport, where they can be used and who owns the cars (i.e. private or fleet operator). These new use cases drive new business models that apart from requiring new organizational structures and competencies also demand automakers to consider several aspects. Römer et al. (2016) say that OEMs will need to evaluate level of customer ownership, branding, data ownership, privacy & security and intellectual property. Importantly, they write that partnerships are imperative to success in AD. Arguing that no single company has the ability on its own to cover every key element in a connected mobility experience, they are proposing that "*The first OEM to build a compelling partner network will secure the pole position and have the best chance to lead and win the race."* (ibid, p. 34).

Moreover, new cost structures associated with new models using automated cars will need to be evaluated by OEMs. Primarily, the large upfront investment cost of acquiring a fleet of AV will be significant by 2030 for a MaaS business model. Collie et al. (2017) estimate that the cost for a single automated vehicle (AV) will be $39 600, implying the need to achieve high utilization rates to reach a satisfying return on investment. However, achieving high occupancy could provide noteworthy cost per mile advantages to previous ride-hailing and private car ownership, although the amount is under debate. UBS, an investment bank, reckons that the cost per mile for a robo taxi service could be as low as $0.7 per mile, compared to $1.2 per mile of a private vehicle (The Economist, 2018c). Barclays write that costs per mile could be as low as $0.3 per mile (Johnson, 2015) and BCG proposes $0.5 per mile (Hazan et al., 2016). Economies for shared AVs (i.e. share mobility service with other customers simultaneously) put prices to even lower costs per mile per passenger (Johnson, 2015; Hazan et al., 2016). Bösch et al. (2017) on the other hand puts forward the argument that previous analyses on shared AVs are largely neglecting important cost factors such as cleaning of the vehicle. They do however write that shared AVs make a strong economical case and that OEMs show an interest into these business models, proposing the need for low cost cleaning and repairing of misused vehicles as important to retain cost efficiency. Further, the business case for shared AVs has the advantage of controlling and (geographically) constricting car usage, implying minimization of liability risks as far as ubiquitous AD has not been established and a proven technology.

6 Analysis

The following section entails the analysis of the content provided by the literature review, the secondary data and the primary data. Common themes are being evaluated and differencing opinions and statements discussed to draw a realistic picture of the examined advent of the technology around AI and automated cars.

Primarily follows a categorization of hurdles identified from the empirical findings. The obstacles identified are separated into the distinct categories of technological and further hurdles. The reason for this distinction is that the authors assessed that the aspect of technology is differentiated from the other hurdles as it is the key enabler and also ensuring factor that automated cars can operate in a reliable and most importantly safe manner.

6.1 Technology

6.1.1 Hardware

Both the primary data sources, as well as the secondary findings indicate, that some hardware necessary for AD can pose some hurdles on the car OEMs. AD is based on a computer getting data from a complex set of different sensors. The primary research and the secondary research indicate that the sensors for AD are Cameras, distance sensors, LIDAR and radar. Those sensors absorb the environment, laying the bases for the onboard or off-board computer to take decisions and judgement. Furthermore, the vehicle needs all-time stable access to maps, which is ensured over the internet. Over the expert interviews, most interviewees indicate, that the hardware technology is on an adequate level to ensure AD. Conducting the secondary research shows, that the topic around hardware is barely mentioned by renowned consultancies. This indicates, that hardware is not supposed to be a problem field for AD, since it would have otherwise been thoroughly discussed.

The primary research states, that connectivity for the real-time mapping of the car is indeed of utter importance. Furthermore, if the computing power for the vehicles is located in a computing center, Connectivity is also necessary to transfer the computed information. However, there is no consensus between the experts, whether car connectivity and mobile internet connections are currently on a level, which is sufficient for AD. The secondary research backs the primary researches findings up in terms of the importance of car connectivity. However, also the secondary research stays reserved in evaluating the sufficiency of connectivity for AD. Concluding the researchers find, that mobile internet and connectivity are technologies of utter importance for AD. The status quo of the technology is hard to determine though, since opinions vary heavily on whether the technology is ready to support AD.

6.1.2 Software

The second technological hurdle is the software side of AD. The software capabilities are responsible for the decision taking part based on the data. All interviewees were agreeing on the fact, that ML will progress to a state, that AD will be possible. That strongly indicates that the software part is not considered as a major hurdle for the advent of AD. However, the secondary research poses a couple of valid hints towards the software side of the AD Construct. First, the ML abilities as of the state of right now, are having significant restraints that need to be abandoned if AD shall be made available. Currently, humans are manually labelling traffic signs in order to feed the machines information about traffic situations. In order to increase the amount of data that the system has available deep learning systems must be developed, that are compressing given information and create new out of it. The secondary research also indicates that Artificial Neural Networks can be created to increase the intelligence level of the computers and therefore establish a more human-like decision making process and better judgement. Taking together the findings of primary and secondary research it can be concluded, that the software side still has some way to go to establish safe AD. However, both the primary and the secondary research implicates, that the software hurdle will eventually be overcome and AD will be possible.

The technological hurdles result in the question of safety, which is of utmost importance for AD vehicles. Both the primary findings and the secondary research agree that safety will be a hurdle for car manufacturers to overcome. Summarizing the opinions from the interviews, the main question at hand regarding safety is how to determine that an Autonomous Vehicle is safe. Undoubtedly it would be ideal, that an autonomously driving car is safe to a level, that there will be no crashes and no casualties on streets anymore. However, this will not be the case and is currently also not the case with humans behind steering wheels. The opinions on how to establish, that an autonomous vehicle is safe were diverging. Repeatedly mentioned is the need to rack up driven miles to gather driving data and make proof of concept, both from primary and secondary sources (Kalra & Paddock, 2016). Although, to make it feasible to overcome the failure rate hurdle it is clearly necessary to enable software simulations to conduct test drives to gather miles simultaneously to physical test drives, as if not done AD will take decades before it is proved safe. Considering the large scale investments into the area, it can be argued that these complimentary methods of test drives will be facilitated.

6.2 Further Hurdles

6.2.1 Legislation

One of the key hurdles that was recognized and highlighted throughout the empirical findings, primary and secondary, was the issue of legislation when it comes to letting AV onto the streets. Importantly, it was revealed to contain several dimensions which have an impact on automakers both in terms of implementation and expansion. The local divergence of regulations that dictates different traffic rules and whether or not automated cars are allowed to drive in particular regions is undoubtedly a major constraint to OEMs, with converging view from the interviewees and Cornet et al. (2017). It purports from a technical standpoint a challenge in that decision making algorithms need not only to be highly adaptable in order to be used in different infrastructure contexts, but also that driving data needs to be obtained from different areas in order to facilitate automated driving vehicles. Interestingly, this points toward that a global industry is facing a hyperlocal problem that can influence certain OEMs capabilities to provide automated driving experiences in new areas. Indeed, interviewee C's input into the particular case of solely allowing domestic automakers to test automated pilot vehicles on local roads in China highlights the complexity of acquiring driven test miles for OEMs in particular markets. In addition, Interviewee G's input that the issue of liability constitutes an issue that can be difficult to overcome, resonating with the writings of Römer et al. (2016).

Interviewee C and Shladover (2017) both too argue for that regulators lack of understanding of the underlying technologies hampers implementation efforts. Fundamentally, determining the acceptable failure rate of autonomous vehicles for regulators appears to be of great concern, if it needs to be at human levels or beyond (Hsu, 2017). It is arguable that it would be seen as worse for a machine to cause an accident than a human, as it is not subjected to the same societal acceptance or understanding of error as a human, pointing toward a rationale where machines will be demanded to reach a stage where the failure rate outperforms current operators. Certainly, viewing the benefits of AI-technologies of reducing costs and enhancing asset utilization outlined by Bughin et al. (2017) it could be argued that such benefits are not reached unless the machinery can show substantial improvement to previous products and services.

6.2.2 Ethical

In line with Shladover (2017) several of the interviewee subjects held ethical questions to comprise an obstacle that needs to be overcome. The consultant interviewees' example of having an automated car in an inescapable situation with fatal outcomes posits dilemmas that even for a human operator would be difficult to assess, which can happen in worst case scenarios on the roads. In line with the review of Agrawal et al. (2017) it is the tacit nature of the desired outcome in such events that creates the challenge for ML algorithms to mimic human judgement. Understandably, it posits hard debate surrounding the ethos of valuing possibly fatal outcomes to another. Further exacerbating the issue, who is going to make the decision for what are the desired end results? Interviewee G's illumination of market research being conducted in the area using crowdsourcing reveals one possible solution to the problem. However as it impacts every road user and is a question of life and death, and thus largely play into the domains of consumer trust, it will likely constitute a hurdle for OEMs for years to come.

6.2.3 Competencies

Inherently, in general OEMs are severely lacking the appropriate skillsets and capabilities to realize and utilize automated driving features of high levels. Concretely, it is the needed capacities to deliver novel business models in the MaaS configuration. The interviewees disparate views of the importance of relying on connectivity when automating vehicles was offset by the fact that capabilities in the connectivity space, i.e. data management, cloud infrastructure and software prowess are fundamentally necessary to support the radically different business proposition. In line with the research of Baines & Lightfoot (2013) and Ambrose et al. (2017) the execution of delivering new offerings based on services for manufacturers requires streamlining of operational capacities to support the new system, which is found in the interviewee findings and writings of Beiker et al. (2016) and comments of Volkswagen's CDO (The Economist, 2018a). As automakers are currently tuned towards a business model of manufacturing focus, the advanced result & use-related services described by Vargo & Lusch (2004) & Williams (2007) which corresponds to the offering of automated vehicle properties will demand business model configurations in line with Sachsenhofer (2016) to accentuate new value offerings. Considering business model management in Sachsenhofer's argument in light of servitization challenges outlined by Baines & Lightfoot (2013) & Ambroise et al. (2017) it would seem from the research findings that OEMs will need to diversify and reconfigure their business models. Interviewee A's input that double operational models will need to be run for quite some time prior to a successful merge of current and future business opportunities indicates that significant time and effort will be needed to develop capabilities that adapt a customer centric value proposition of a MaaS-model. As the technologies involved posit cars to become computers on wheels, customer centric value propositions outlined by Osterwalder (2014), Rogers (2016) & Barnes et al. (2009) appears to become the rule rather than the exception in the industry. Several interviewees mention of customer-orientation as key purports that establishing the right competencies to enact such business will constitute a major hurdle for any OEM vying to compete in the automation race.

6.2.4 Collaborations

An interesting finding from both the interviewees and the secondary data was that the dawn of ML applications in automating vehicles blurs the traditional boundaries of the industry and gives rise to new business eco-systems. Multiple secondary sources have mapped out the rapid increase in unexpected partnerships, alliances and acquisitions (Kerry & Carsten, 2017; The Economist 2018c; Cornet et al., 2017; Römer et al., 2016) and so did the interviewees resulting from the efforts invested in automated vehicle technologies. The empirical findings show that it stems from acquiring the right competencies and infrastructures needed to compete, as the OEMs lack the software and data management capacities of tech companies active in the space such as Uber and Google. Supporting the view of collaborations of Shilling (2013) interviewee G and E said that collaborations will be absolutely necessary for OEMs to compete effectively as it enables access to other organizations where new skills can be secured that are needed to develop and commercialize AV. Further, several interviewees and Römer et al (2016) positioned the argument that OEMs will need to ally strategically in the new automotive ecosystem. For industry rivals to collaborate will likely not be an easy task. Interestingly, Interviewee C described the further need for that internal development of AI capabilities and supporting cultures for a transition towards autonomous. Drawing on the example of Ford Motors recently employed CEO with background from an autonomous startup acquisition, it can be considered that in the coming years it will be increasingly important to not only collaborate for particular organizational skills and competitive positions, but also as a way for OEMs to find talented individuals who can drive the push for new business models and value propositions. Hinted at with the large scale investments into autonomous technologies, OEMs hurdle to effectively acquire the right collaborations will be a difficult challenge to overcome.

6.2.5 Cost

A factor that came across to heavily affect the diffusion and use of automated technologies is the cost of implementing, acquiring and maintaining AV. Primarily, the interviewees commented on that current sensor systems carry high costs, for instance LIDAR systems. That being said most interviewees were quick to assess that with increased process and product innovation the costs are most likely to radically drop in the next few years. Cornie et al. (2017 and interviewee F both cited that the implication for OEMs to acquire a fleet of AV would imply large upfront investments which fundamentally alters balance sheets and resistance to economic cycles. In addition, Interviewee C's input regarding labour cost of a human driver highlights how the issue of cost can of be particular concern of implementation of AV in emerging markets. Indeed, as most current cost studies are based on primarily western accounts it implores that the need for cost efficiency in developing economies is critical to accomplish in order to compete with the current use of human drivers.

6.2.6 Customer trust

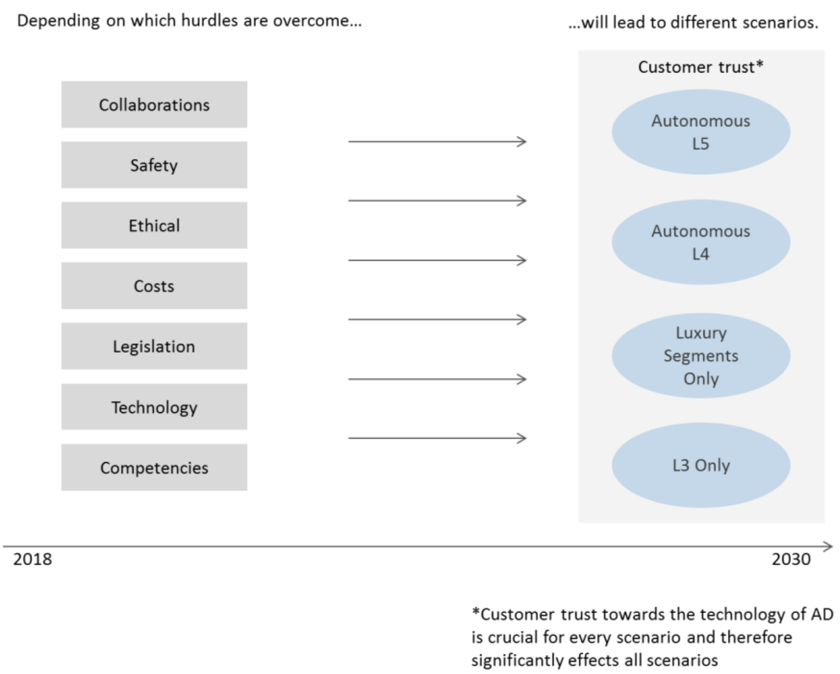
Being asked about customer trust, all interviewees stated, that it will be an essential hurdle to overcome for the technology of AD. Even if a perfectly safe AV is designed, that has full permission to drive on the streets; consumer distrust would be a major hurdle towards the technology. Customer trust could be established by providing safety KPIs of AD or driving references. However even a proven safe car might cause some customer trust since it is based on cloud and internet services and such services are often subject to cyber-attacks, which resonates with the indicated technology hurdle of cyber-security of Shladover (2017). Furthermore customer trust is according to the expert opinions also depending on the different generations. Older generations would probably distrust AD more than younger generations, based on the fact that millennials grow up in an environment coined by a high level of automation.

6.3 Scenario Analysis

Having established different substantial hurdles to the development of fully AD vehicles, the authors decided on doing a scenario analysis to determine the impact of self-driving cars enabled by ML on the value proposition of the car OEMs. In the scenario analysis the primary and secondary research data are evaluated and combined with the knowledge gained from the literature review. That enables the authors to sketch the most adequate scenarios of how AD will affect the car automotive industry until 2030. The scenarios were generated by focusing on the level of AD available at the set timeframe, as the authors assessed that by evaluating the capability of automated cars archetypical use cases, products and services could be determined which constitutes the basis of discussion for how the OEMs value proposition can be affected. It resonates well with the writings of Osterwalder et al. (2014), Rogers (2016) & Barnes et al. (2009) in regards to value propositions, as it regards the underlying elements of the value proposition construct and importantly how it can address customer jobs through new use cases enabled by novel goods & services. It implies that by utilizing the prowess of autonomous by 2030 as a fundament for scenario generation, the analysis of how the value proposition can be affected is facilitated.

Figure 13 summarizes the above evaluated hurdles, which form the basis for which scenario is most likely the case for 2030. Assessed by the authors four distinct scenarios can be generated for that year: Fully Autonomous (L5) Vehicles available, Highly Autonomous (L4) Vehicles available, Autonomous Capability for Luxury segments only and Partially Autonomous (L3) Vehicles available. Customer trust is marked as an overarching factor that influences each scenario, since if not overcome users will not trust the utility of offered products & services. Each scenario is discussed further down in the analysis.

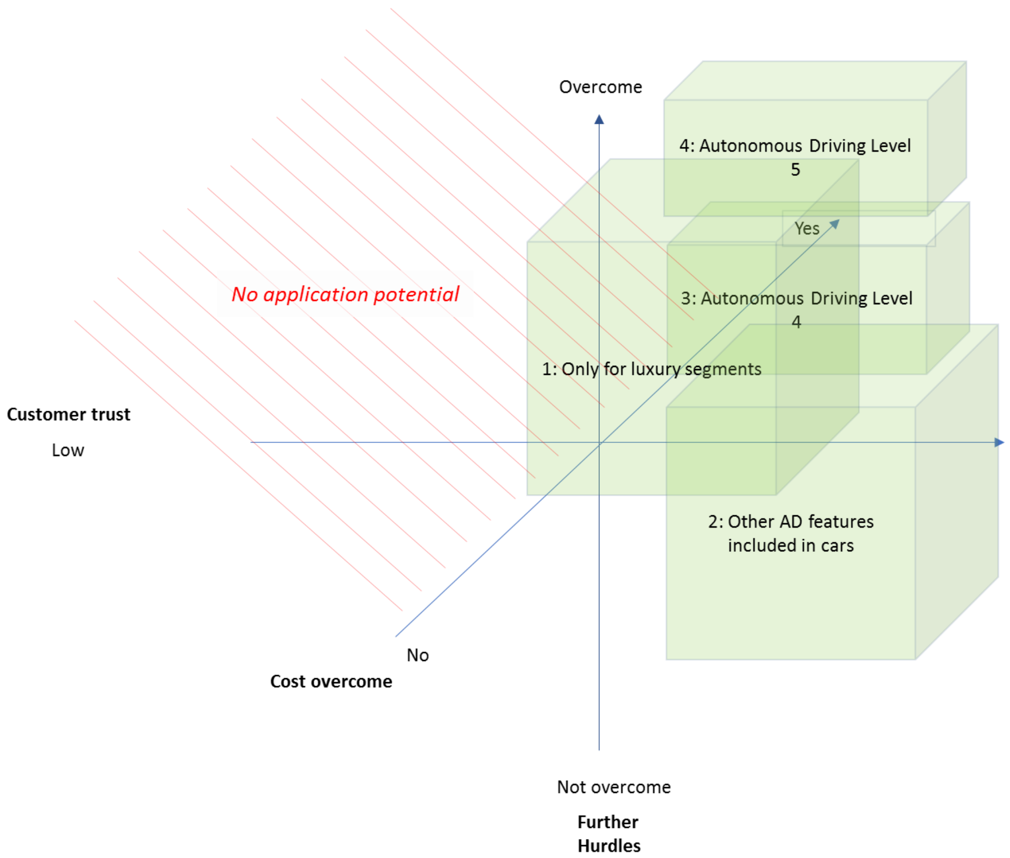
Figure 13 - Scenario Generation (Authors' Illustration)



The following graph pictures the scenario generation from figure 13 in a three dimensional scenario analysis. Customer trust, describes the readiness of the customer for the technology. Cost overcome defines whether the cost hurdle to commoditize AD will be overcome and

Further Hurdles corresponds to the other identified obstacles mentioned in figure 13 and the above analysis.

Figure 14 - Scenario Analysis Matrix (Authors' Illustration)



First off it is to say, that if the hurdle around customer trust is not to be overcome, then AD will have no application potential. This hurdle could be particularly hard to overcome for older generations. Generations that are not used to machines doing human jobs, could potentially have great distrust towards an AV transporting them. Younger generations that are used to a higher degree of automation will most likely trust AD and hence the authors assume that this hurdle will be to overcome.

6.3.1 Scenario One - Autonomous Achieved, however at Great Cost

In *scenario number one*, the costs for AD features will not get to a level on which it would be economically feasible to introduce it for the masses. If the hurdles around safety, legislation will be overcome, then AD in this scenario will most likely be a feature for luxury brands that can afford to justify the high costs towards their customers. Regarding the Business models and Value proposition of the car OEMs, this scenario would be the least disruptive one. AD would be a feature in the luxury models of the different brands, that have established safe AD, but the value proposition will only change slightly, since the OEMs are still selling cars to the customer. The customer of luxury models would now have a car that over the main part of the driving distance handles itself, which would be the main shift in the value proposition. In terms of Business models changes, it would be a Business model Reconfiguration by the most. Firms would still use the same concept to capture their value, which is the definition of a business model and hence one can argue that the business model will stay the same. Since the value proposition does not change, no drastic changes to the business model need to be made. The customer segments will stay exactly the same and the customer relationship over dealerships will most likely also be the same. Summarily one can notice that scenario number one will not disrupt the car automotive industry radically.

However, watching technology trends over the last decade, it is noticeable that technology costs usually drop very quickly as soon as process innovation has followed the product innovation. Cheaper production processes are then available and former innovations become commodities. Hence, it can be strongly assumed, that the cost hurdle for AD will be overcome eventually.

This leads to the analysis of the next hurdle around safety, legislation and the ethical aspect. To determine whether this hurdle will be overcome one cannot rely on past trends, since this will be a completely new issue going through local legislation processes and safety procedures. It is to stress, that the permission of AD vehicles falls under the responsibility of local governments. Those governments will most likely have different technological and safety requirements towards the AD cars and hence it is difficult to generalize whether this hurdle will be to overcome for the world wide car automotive industry. However, the fact that all car manufacturers and suppliers are working and investing heavily in AD, can be interpreted as a sign that this hurdle should be overcome at some point. Industry-wide investments argue for the case that legislative bodies will be subjected to exposure of the technology's properties that facilitates a better understanding of the possible benefits of safety and efficiency. This in turn should result in establishment of regulatory & ethical standards that enables AV that meets safety criteria to drive on the roads. Summarizing it is to be stated, that this hurdle will most likely to be overcome in countries and legislation areas, where AD was thoroughly tested and enough data for the AD software available.

6.3.2 Scenario Two - AD Not Achieved

Although, should those hurdles not be surmounted the case of AV will be in *scenario two*. The second scenario entails that the hurdles regarding technology, safety and legislation has not been overcome by 2030. Possible injunctions to technology could be such that challenges in terms of ML software prowess has not been strengthened enough to support high or full automation levels. Further, regulatory bodies can still at this point be impeding the possibility of allowing automated cars on the roads as safety standards have not been met. It results in that OEMs will principally focus on their current offering including ADAS product features on SAE level 3. In such a scenario automakers will have developed advanced connectivity based services that will constitute new value offerings. Following the argumentation in the previous paragraph and the findings in table 3 & 5, this scenario is unlikely.

6.3.3 Scenario Three - Level Four AD Achieved

Having established that it is likely that these hurdles will be overcome it leads to the question, which AD Level will be introduced within the industry. AD on level four means, that the car will drive the bigger part itself, but will need some driver interference in certain situations. AD level five enables cars to drive without any driver interference at all times. AD level four will lead to *scenario three* where cars will drive autonomously under most conditions. The conditions under which the cars can drive autonomously are non-complex situations such as highways. In such a scenario the concept of fleet management will most likely become essential. Cars going the same direction to the same destinations will team up in fleets and fully autonomously drive themselves. Customers would appreciate such offers, since they would gain additional time during their highway rides. It is fair to say, that there is a customer demand for a thorough fleet management. Customer demand and competitive advantage are two of the driving forces towards servitization (Oliva & Kallenberg, 2003) and hence the literature review also supports the theory, that car manufacturers are being pushed towards mobility service providers under such conditions resonating with the logic of Vargo & Lusch (2004). For the car manufacturers it will have the following implications. First, they would need to acquire or develop software skills to manage such fleets. Cars from different car manufacturers would need to be connected over the same cloud, that such a brand-overlapping fleet management is possible. Organizational and structural changes in the direction of cloud, data and software management will need to be made.

Applying this scenario on the "sweetspot" function outlined by Interviewee C draws the following conclusions. The effort to introduce such a service would be medium high for car manufacturers, since they need to acquire novel competencies and make some adaptations, but nothing radical. Also the value added for the customer would be medium high, since it would enable a “taxi service” for most situations and save an essential amount of time, alleviating customer pain of driving and creating gains of time to pursue other activities. It accentuates the comment of Interviewee E through the lens of Osterwalder et al. (2014). However, for other parts the customer would still have to steer the vehicle, which seen through the view of Interviewee G can be positive as it allows the user to retain the feeling of control. It can be concluded, that such a scenario would provide a

The car manufacturer´s business model will change, leading to double business models for the car OEMs. The different business models will be described more thoroughly in the next paragraph. The cars will still be sold to the end customer, but will have AD as a feature. Compared with scenario one, the broad masses will have access to AD and not just the luxury model customers. The fact, that now the broad masses have access to cars, that are able to drive autonomously for the bigger part, will most likely lead the car manufacturers to fleet management services. Such a fleet management can be seen as a MaaS offering comparable to an advanced services described by Baines & Lightfoot (2013). It could be that customers can have an application on their phone over which they can insert their destination and as soon as the cars are in an area where they can drive autonomously, fleets are composed and drive together to the same destination.

In terms of business models and value propositions, this scenario is hard to analyze for the following reasons. The cars are still sold to the customer and the car manufacturers will still earn their profits by selling the cars. However, their value proposition to the customer changes significantly, since the cars are now able to drive autonomously for the major parts, which describes a significant value add. This adaption of the value proposition can be seen as both customer centric and value centric adaption (Rogers, 2016) and is therefore very likely to happen if the technology allows it. How this value add will be integrated in the business model is hard to forecast. It could be, that the cars having fleet management as a feature on board will be sold for a higher price, so that the car OEMs gain more profits at the point of selling and in exchange provide MaaS offers. However, from a long-term economical perspective this model would not make much sense, since the car OEMs will have running costs for the MaaS offer and selling the cars more expensive will at some point not be economical anymore. That being established, it will be likely that consumers buy the cars for a certain price and will pay a monthly fee for the MaaS, or be able to purchase software upgrades through over-the-air updates as mentioned by Mahut et al. (2017).

This would lead to two different business models of the car manufacturers. They would stick to their traditional business model and generate profit by selling cars to the customer and additionally make some profits of their mobility-as- a-service offerings. It is hard to determine whether the traditional or the new business model will generate the highest profit for the car OEMs. One approach would be to sell the cars for an expensive price and offer a rather cheap MaaS offer. The customer would bite the sour apple at the beginning and the car OEMs would have a big profit upfront and little profit over the lifetime of the car. That would make the old traditional business model for the automotive industry more significant than the new one. Another approach would be to sell the AD cars very cheap, get a large customer base on board and charge higher prices for the MaaS. That would potentially lead to larger profit streams, since more customers would buy the cars and the profit would be gained over a longer time period. Which Business models and pricing models the car OEMs will apply is currently not determinable. In terms of Business model reconfiguration (Sachsenhofer, 2016), the authors would interpret this as a Business model Innovation, since it is a radical new Business model introduced by the organizations. Car manufacturers will use the new Business model to conquer new market segments (Dogson et al., 2012), MaaS and extend their product and service portfolio.

6.3.4 Scenario Four - AD Level 5 Achieved

Scenario four in which AD on Level 5 is possible would be the most disruptive case for the automotive industry. If AD on Level 5 will be introduced it means that cars can drive on their own without human intervention ubiquitously (Shladover, 2017), thus removing the need for a driver to operate the vehicle. Found in the primary and secondary data, and assessed through analysis of the identified hurdles, the authors deem it is highly unlikely ubiquitous driving capabilities are available at the year of 2030. As fully autonomous vehicles have significant prerequisites in order to function, including thoroughly mapped areas, driving data and supporting connectivity & adapted infrastructure, it is infeasible that ubiquitous AD is available in ten years' time. Having this assumption established the generated scenario has two other assumption derived from the expert interviewees. Firstly, outlined by Interviewee D people do not mind how they travel from point A to point B, i.e. the customer job to be done covered by Osterwalder et al. (2014) & Rogers (2016). Secondly, the concept of car ownership is changing, as millennials in particular are increasingly viewing automobiles as a good used for transportation rather than a personal belonging, further fostered by the evolution of new mobility solutions mentioned by Mahut et al. (2017).

Having these assumptions in place, it is now to determine for what particular use cases AD level 5 would be likely to have in the scenario. Reviewing the established hurdles through the lens of Interviewee C's "sweetspot" function it becomes apparent that to overcome the hurdles for large scale autonomous capability enormous effort would need to be made. Apart from the technological difficulties of overcoming software hurdles related to ML & deep learning algorithms there needs to be a change to infrastructure and prevalent regulations, further amplified by that the vehicles and their data must be managed and a massive IT-backbone and service must be in place 24/7. It all implies significant costs. However, the value added for society would be enormous on different levels. Firstly, it would be highly convenient for customers to have a pay-per-ride robo-taxi service established, since high fixed costs to acquire a vehicle is mediated, not to mention that such a service would give access to customers who are not able to drive a vehicle. Secondly, such a robo-taxi service with a higher utilization and sharing potential would help to increase the sustainability of private transportation & decrease costs per driven mile (Bösch et al., 2017; Hazan et al., 2016, Johnson, 2015). Lastly, large cities often face massive traffic congestion issues. Over a robo-taxi service this problem could also be tackled. Summing up one can see that we would be at the very top, right corner of the sweetspot function, offering great value at large costs.

Based on these assumptions, it is possible, that a robo-taxi service will be introduced for areas where the value function is providing proportionally larger value than the effort required to implement it. Analogous to the empirical findings & hurdle analysis it is arguably motorway & particular metropolitan areas that satisfy these criteria, where road conditions satisfy the safety requirements. Further, and most importantly, where a critical mass of customers can be targeted in order to maximize vehicle utilization rates and achieve scale that can correspond to the effort made to achieve the self-driving area.

Distinguishing between these areas and others highlights the differences in effort to establish these geo-fenced areas. For instance, in urban areas the effort of AD on Level 5 is less than in rural ones. This is due to the fact, that data for the software systems is available and the streets are well-mapped and also frequently reviewed. It is essential for enabling AD, as the road conditions needs to match the ability of ML decision software to perceive its environment correctly. Otherwise safety cannot be ensured, which is the key parameter for a self-driving car to have to avoid failures and correspond to regulatory standards. Furthermore, the benefit of such a robo-taxi service in urban areas is way larger for the customer, since a large proportion of the customers are driving the same routes. Another example is the case of certain areas in emerging economies, where large numbers of customers can be targeted but the costs to establish the service is too great in order for it to become profitable. Illuminated by Interviewee C's cost example of drivers in China in parallel to the inputs of Interviewee F and the cost estimations of Collie et al. (2017) & Bösch et al. (2017) to acquire and maintain a fleet of fully autonomous cars, it becomes apparent that implementation in many developing markets will take longer time due to the low cost of hiring human drivers.

For car manufacturers, this will have radical implications for their business model and value proposition. In high value areas, the value proposition of car manufacturers will shift to offering a transportation service to the customers, leading to a Business model Innovation (Sachsenhofer, 2016). In high value areas cars will primarily be offered through monetized mobility services, likely surmounting vehicle sales. Since a lot of people are living in these areas or frequently travel within them, one can assume that now the MaaS business model will take a significantly larger part, than under AD level 4.

An essential issue at hand under this scenario is the question of how such a robo-taxi service will be managed. The literature research indicates that radical innovations are mostly managed through collaborations, in order to exchange necessary capabilities and competencies that are needed to manage innovations on a bigger scale. Such a robo-taxi service is without a doubt the largest innovation hitting the car automotive industry. In both the primary and the secondary research it was discussed, whether the robo-taxi service will be done by the car manufacturers themselves or in collaboration with an organization that possesses great data and software management capabilities. Most interviewees are of the opinion, that the service will be provided under the umbrella for instance Uber. The reason being is, that Uber already has built up a customer base and developed excellent coordination skills regarding their taxi fleet, that they are managing. Furthermore, they possess the IT-infrastructure and data management skills needed to bring such an innovation to the market. The literature review, the primary and secondary research all point in the direction, that such a service will be conducted through collaborations.

However, one cannot underestimate the strategic implications for car manufacturers if such a robo-taxi service would fall under the umbrella of a second party. The car manufacturers would lose a lot of leverage and profit for an innovation, that is largely developed by themselves. Fundamentally, the OEMs would lose the customer ownership, severing a linkage between manufacturer and consumer that has been constructed for years. Long-term it would be strategically preferable to develop the software and data management competencies in house for the car manufacturers to ensure independence and keep the profits within the industry. It is also accentuated by the writings of Baines & Lightfoot (2013) & Ambroise et al. (2017) that outline that an effective servitization strategy is best executed through operational alignment to provide an integrated customer experience, advocating an importance to retain the customer relationship. In such a scenario it would be an option for the car manufacturers to team up and form strategic alliances between the different competitors, and partner with or acquire firms with expertise in AI-technologies. Such alliances and partnerships would enable them to have the resources necessary to develop such software and data management skills. However, it could also spark significant governance issues and operational alignment between OEMs to facilitate such service models. Currently based on the primary findings, most experts point in the direction that a robo-taxi service would be established between a collaboration of an existing firm such as Uber with the car manufacturers, but since such a scenario is further down the road it is currently hard to specify.

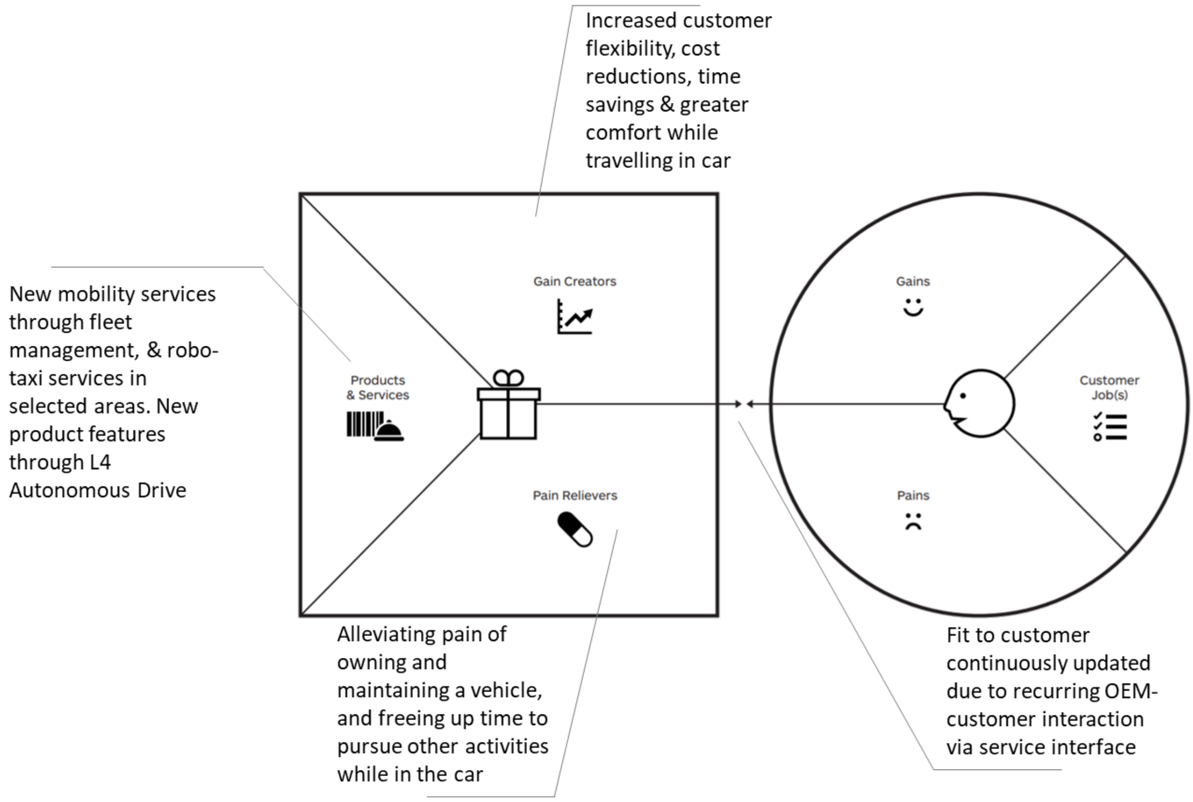
6.3.5 Scenario Analysis - Summary

Based on the conducted analysis, constituting the opinions of the interviewed experts, the secondary research and the identified hurdles, the authors are of the opinion that by 2030 the most likely scenarios are either 3 or 4. Establishing L5 AD would take an enormous effort in any use case which is not only depending on AD-technology, legislation and safety issues. As mentioned, OEMs need to establish collaborations in order to provide their products and services in the rising eco-system of autonomous, either amongst themselves and/or with software firms. Creating efficient and mutually beneficial cooperation takes time and effort, in addition to the efforts to establish the necessary infrastructure to support AD.

Reviewing the findings from the interviewees and the secondary data regarding the likely level of AD in 2030 sheds the light of diverse opinions. Consultancies are largely claiming that 2025 is the year when L5 will become available, with loosely elaborated use cases. However from the interviewees a pattern emerges that outlines that ubiquitous L5 is still far to be seen. Interviewee B’s input that level 5 implies full autonomy under any circumstance points to that certain criteria needs to be met to utilize it, namely areas with the right infrastructure, weather conditions and data, purporting a stance that ubiquitous L5 is more of a vision than a tangible goal. The consultant interviewees, Interviewee C & Interviewee E all point toward that L5 will be achieved by 2030, but only in areas and use cases that meet the established criteria.

Converging these inputs, and observing the identified hurdles, it is arguable that the case for Scenario 4 is most likely, where L5 is achieved but solely in high value areas. The reasoning is that the technological capacity will have been overcome, but costs and societal barriers such as legislation and customer trust will need both time and resources to be traversed. Implications for the OEM business model will however be very similar to that of Scenario 3, meaning the use of dual business models where one is focusing on traditional vehicle sales and a new one that is a MaaS-business model focusing on fleet management & robo-taxi service provision in selected areas. For the value proposition it critically means that OEMs will offer new services that create new gains and alleviate pains simultaneously as it puts value & customer-centricity to the OEM business model, propelled by that the customer experience within the industry eco-system will prerequisite OEMs to foster strong customer relationships in order to retain customer loyalty. Figure 15 summarizes the effect on the value proposition by using the Value Proposition Canvas outlined by Osterwalder et al. (2014).

Figure 15 – Effects on OEMs Value Proposition in Selected Scenario (4) (Authors' Illustration)



7 Conclusion & Suggestions for Future Research

This thesis has been an exploratory study with the outset goal of covering certain aspect of one of today's greatest discussion topics, that of the implementation of AD cars. Reviewing the findings in the dissertations analysis which combines the qualitative data gathered through expert inquiry, secondary research & contextual background and theoretical concepts, a pattern emerges in what direction the development can likely go in the coming years. Although the path there is clouded in uncertainty of future developments and injunctions, several arguments indicates the likeliest scenario.

Hence, in response of the study's primary research question:
How will the car manufacturers' value proposition be affected by automated vehicles enabled by machine learning technology until 2030?

The authors outlined four possible scenarios for the automotive industry by 2030, affected by outlined hurdles, level of value added and underlying costs to enable a shift to AV. Argued in the analysis, based on the dissertation inquiry, it was assessed that the most likely scenario for 2030 based on today's sources is one where automation has achieved SAE level 5 (i.e. Fully Autonomous), but only in geo-fenced areas and under certain conditions, where the large costs and effort needed to achieve full automation can be completed and provide sufficient value to customers and return on investment for OEMs. Technological advances, cost reductions and adapted legislation will by this time result in that high automation vehicles can be driven outside of these areas, but with the constant need of a human operator to take over in case the vehicle systems cannot handle a situation, whereas backup failure systems enable a safe transition between man and machine to ensure safety. Based on this scenario, it is deemed that OEMs business model will evolve into an unprecedented dual model, where one former model centered upon product sales and added-services will be effectively complemented by a MaaS-model which enacts a fundamental change for automakers to simultaneously become either collaborators with fleet operators or possess proprietary fleets themselves. Importantly, as the business environment shifts to an ecosystem of a myriad of players, automakers will need to collaborate with suppliers and other OEMs to establish competitive positions from where they can target end-users with new value offerings.

Following the developed scenario, the value proposition of OEMs will be largely altered by AV at the indicated level. Firstly, for a significant number of customers in selected areas AV at level 5 provides not only a novel service offering and offers a way of solving the customer job from travelling between point A and B; it alleviates customer pains of maintaining the vehicle, gives them gains of significant cost reductions and fundamentally changes the transaction of acquiring a vehicle from an actual purchase to a click through a ride-hailing user interface. The subsequent and continuous direct linkage between the customer and OEM will promote value- and customer-centric offerings previously unseen in the industry, as automakers ongoing customer relationships through connectivity advocates adapted value propositions catering to consumer needs. For instance, provision of robo-taxi services appealing to different market segments and availability to vehicles with different properties that fit customer use cases can be conceived at this time. Secondly, several current value propositions will be enhanced and become more strategically important than before, such as safety, in-vehicle comfort and services. Thirdly, for customers that want to own their vehicles and/or live in areas without level 5 infrastructure, level 4 will mediate several customer pains through greater comfort and enable customers to pursue other jobs whilst having their automobiles operating the vast majority of the time.

To answer the thesis secondary research question:
What are the major hurdles to car manufacturers' implementation of automated vehicles?

Throughout the empirical findings, primary and secondary, a multitude of challenges was recognized to affect the future of OEMs launching AV on the roads. However, many of the sources converged on a few set of factors that set themselves apart from other obstacles: Technology, Safety, Legislative, Ethical, Collaborations, Costs and Customer Trust. Primarily, the readiness of the technology is of central concern to the topic, correlated to current lacking capacities of hardware and software components needed to facilitate cars to drive on their own. Current generations of sensors, LIDAR and cameras provide hardware constraints that need to be overcome in order to provide software with the precise data that enables correct decision making. Moreover, the power of ML software will be need to be further developed and fed with large quantities of driving data to ensure reliability and safety on the roads. Safety is a fundamental issue, as a wrongly computed move by the machine can have fatal consequences. Further, the failure rate of AV is argued to be required to show substantial improvements compared to human peers, adding to the hurdle's importance. Legislative bodies in different regions and cities demands adaptability of systems to different regulatory settings, and resolving the question of robot ethics comprise a key challenge to makers of software. In addition, in a new industry setting where collaborations will be necessary to compete OEMs will be posited the challenge to partner up to acquire the right technologies, skills and alliances to win and survive the race. Lastly, overcoming issues of customer trust and the costs of developing, manufacturing and maintaining AV pose significant barriers to penetrate for any OEM.

In conclusion, this study contributes to the widely discussed phenomena of the impact of self-driving cars, having its basis in theoretical and qualitative inquiry acting as the point of interpretation for the researcher's analysis. Summarily, by 2030 the value propositions of the OEMs will take on new dimensions not possible today, powered by the algorithm and complimentary technologies, causing disruption in a traditional industry. Several obstacles in the way were identified and the authors narrowed down the key hurdles through triangulating primary & secondary findings in combination with theoretical concepts from scholarly literature. The industry experts' views show that the research area's relevance is of the highest order in an industry landscape under upheaval with the advent of automated technology. That being said, throughout the inquiry it became clear that the debate of car ownership in times where cars can drive on their own is highlighting a field that requires further research efforts. Illustrated by the interviewee from CEVT, the sociocultural significance when it comes to car ownership in certain markets pertain additional questions regarding the diffusion and speed of implementation of automated driving. Arguably, it would be interesting to study the short- and long term significance of such embedded hurdles and implications in particular markets.

7.1 Suggestions for Future Research

The research results for this dissertation are based solely on qualitative interviews and secondary data findings. Therefore, the study's assertions can be complemented by a quantitative study which can provide statistical accuracy and achieve further insights into what the major hurdles are to OEMs implementation of automated cars, and importantly the value proposition transition. In addition, one of the limitations of the thesis is that it does not seek to explore the complete dimensions of each hurdle. The researcher's focus was directed at identifying and discussing the key obstacles, and less in terms of giving a comprehensive account of the characteristics of each challenge ahead for automated driving. Hence, it would posit for future research the proposition to study these properties. For instance, one of the key hurdles identified that also is essential for an OEM to deliver superior value propositions in the coming autonomous ecosystem is collaborations with suppliers, competitors and tech companies. An inquiry that assesses how automakers and tech companies can collaborate effectively to generate successful business outcomes would therefore constitute a relevant research topic. Moreover, a core limitation of the thesis is that only experts from Swedish organizations have been interviewed for insights into the field as a whole. It leaves out important dimensions that could potentially exist in OEMs and markets located in alternate settings, such as the US and Asian contexts. One such critical subject is the one of car ownership as it was indicated from the empirical findings that it carries largely divergent sociocultural implications between different regions. As implored in the thesis, one of the pain alleviators of automated cars is that it can reduce the need to own your car to access the mobility customer jobs, however if customers still want to own their vehicles this value proposition will not promote use of fleet operator business models. Therefore, it would be critical to further research this area and discover how this dimension can influence diffusion and use of automated cars. Lastly, an interesting finding from Interviewee E is the potential of a future P2P-market of independent owners of AV, acting as individual "fleet" operators. As it is not within this paper's scope of researching this highly interesting potential phenomenon, it could serve as a basis for other researchers to pursue as a study topic.

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9 Appendix

Interview guide

The Automotive Industry is in interesting times at the moment, where introduction of new technologies, business models and consumer behavior are set to have profound industry implications. ADAS (Advanced Driving Assistance Systems) features are becoming increasingly adopted and coupled with car connectivity can potentially affect mobility. Our thesis is set in this context as it seeks to answer how a key technology trend, ML, can affect and change automakers customer value propositions (i.e. what benefits customers receive from using a company's offering). What new offerings can be conceived in the present day, how is it different from previously, and what are the implications and obstacles in the way for car manufacturers of implementing it? Our work is exploratory and set to the timeframe until year 2030.

1) Describe how your company is involved in the automotive industry? (E.g. supplier, OEM, consultancy)
2) What is your role in your organization, and what are your experiences from automotive?
3) AI technologies are claimed to cause radical transformation in virtually every industry. In what key ways can you see that this will affect car manufacturers?
4) Based on our literature research AD is based on the technique of ML and deep learning. Do you think the concept of AD under the umbrella of the mentioned underlying technologies will progress to a state in which cars will be able to fully drive autonomously?
    a. Do you recognize any other technologies being key for its implementation (i.e. sensors, radar)?
    b. What main external factors can influence the implementation of autonomous?
5) AD is assessed to enable radically different business models compared to the ones of currently used by OEMs. Some say that services will be particularly important such as provision of robo-taxis, what is your take on this?
6) The value proposition is a core concept in business model literature. How can you see that OEMs value propositions can be affected by the introduction of autonomously driving vehicles?

7) New value propositions within the car automotive industry would also suggest that there will be changes of customer behavior within the industry, such as that the concept of car ownership changes. In which direction do you see this development?
8) How do you see automakers enact/will enact the change toward new business models enabled by AD (e.g. collaborations, setting up subsidiaries)?
    a. What would you identify as the key hurdles to OEMs to conduct this transition?
9) The technology enables companies such as Uber and Google to enter the industry through developing robo-taxi services that can challenge OEMs customer ownership. How do you see OEMs handle their relationship with such companies?
10) Car connectivity is closely intertwined with AD capabilities but also requires competencies such as data management and cloud infrastructure. How do you think OEMs will acquire these competencies (e.g. acquisitions, joint ventures, internal development)?
11) Would you say that first-mover advantages are key to win the market in launching autonomously driving vehicles? Or would it suit better to be a fast follower?
12) Any other comments or remarks you would like to give on the topic?

Thank you very much for your time and have a nice day!

Follow-up question

1) By the year 2030, which SAE level do you expect to be available on the market?
    a. Will this be available to the mass market, and will there be any particular restrictions in terms of areas of use?