CHALMERS
UNIVERSITY OF TECHNOLOGY

How autonomous cars can affect the car industry

- Implications for user experience and competition

Master's Thesis in the Master's Programme Management and Economics of Innovation

OSKAR HAGMAN

JOHANNA LINDH

Department of Technology Management and Economics
Division of Science, Technology and Society
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2019
Report No. E 2019:028

MASTER’S THESIS E 2019:028

How autonomous cars can affect the car industry

- Implications for user experience and competition

OSKAR HAGMAN

JOHANNA LINDH

Supervisor: Maude Hasbi

Examiner: Erik Bohlin

Department of Technology Management and Economics

Division of Science Technology and Society

CHALMERS UNIVERSITY OF TECHNOLOGY

Gothenburg, Sweden 2019

How autonomous cars can affect the car industry
- Implications for user experience and competition

OSKAR HAGMAN

JOHANNA LINDH

Master's Thesis E 2019:028

Department of Technology Management and Economics
Division of Science, Technology and Society
Chalmers University of Technology

SE-412 96 Gothenburg, Sweden
Telephone: + 46 (0)31-772 1000

Chalmers Reproservice
Gothenburg, Sweden 2019

Acknowledgements

This thesis was written with support from Coboom. Coboom is a collaboration between Volvo Cars, Stena Property and CGI with the purpose of connecting actors from industry, academia and public sector in order to generate value creation. We want to thank everyone involved in this programme for supporting the process of our thesis as well as giving us the opportunity to participate in interesting discussions and workshops.

As the interviews in this study were quite time-consuming and required a bit of imagination from our interviewees, we want to thank all participants for taking their time and sharing their thoughts on this interesting subject.

We would also like to thank Ingrid Pettersson for taking the time to guide us in designing our interviews. Ingrid's studies within this research area have been a foundation for the thesis and the support from Ingrid was very valuable for us.

We thank our supervisor Maude Hasbi for her support during the writing of this thesis. Maude has given us the confidence to pursue this subject in an independent manner while guiding us and providing us with valuable insights along the way.

After five rewarding and challenging years at Chalmers University of Technology, we would also like to express our gratitude to all the people that have made those years unforgettable.

Johanna Lindh & Oskar Hagman
Chalmers University of Technology
Gothenburg, Sweden

May 2019

ABSTRACT

Autonomous cars have not only been identified as having the potential to change the car industry but also to have a high impact on society in general. Relieving people from driving the car will enable passengers to perform other activities during the ride, which in turn can create opportunities for shaping the user experience. The autonomous technology together with other emerging trends in the transportation industry can also come to change the competitive landscape of the car industry. One such important trend is the expected shift to shared ownership models. This study aims to investigate the user experience in future autonomous cars as well as how autonomous cars can affect the competitive landscape of the car industry.

In order to reach conclusions within this subject, a combination of empirical findings and previous literature have been examined and discussed. The empirical part of this study is based on a qualitative method where the participants get to create collages to express their needs and wants in future autonomous cars.

This study shows that people want to perform most activities within the categories relaxation, entertainment, and socialization. The result indicates that the activities people want to perform within these categories are similar, while the channels used to consume digital content varies. The study discusses the opportunities for a digital platform to enable the users to engage in a customized user experience adjusted to their specific wants. Furthermore, this study finds that there might be a difference in what people value regarding the aspects of an owned car compared to a shared one.

This paper also indicates that the competitive landscape of the car industry can come to change when cars are autonomous and shared. When the industry boundaries expand to include new types of players, the drivers for competition change and new key success factors become evident. While traditional drivers for competition might stay important for car manufacturers, this study has identified new key success factors that will be of high importance for firms providing a shared mobility service. For these players, a critical mass of cars, an installed base of users and networks effects become important factors for obtaining a competitive advantage.

KEYWORDS: Autonomous cars, User experience, Shared mobility services, Car industry analysis

Table of Contents

List of Figures

List of Tables

List of Graphs

1. Introduction
In the following sections, an introduction to the subject matter of the report will be presented, along with the purpose, research questions and limitations of the paper.

1.1 Background
There exists a widespread belief that the car industry will undergo major changes in the coming decades. This is highly driven by new technology and the opportunities it brings. One such technology, that according to Gruel and Stanford (2016) have the potential to revolutionize society in the future, is autonomous vehicle technology. According to experts, by letting computers take over the responsibility of driving, the threat of traffic accidents will drop greatly, while making transportation more efficient and thus more sustainable. Eliminating the need for human drivers will have an impact on everyday life and where people choose to live, which means the technology will affect the composition and function of our cities (Gruel and Stanford, 2016). The most obvious change will be experienced when traveling by autonomous cars; when no one must spend attention and energy towards driving, the time in the car will be spent in a different way. Thus, the technology of autonomous cars will present companies in the automotive industry to many opportunities and challenges, as the industry itself is likely to experience an immense transformation in the coming decades.

Autonomous vehicle technology emerged in the first decade of the 21st century. One division of the U.S military called DARPA, the Defense Advanced Research Projects Agency, had already spent decades trying to develop self-driving trucks, but the technology was still not ready for use. Officials at the agency figured that external actors might be better suited to develop such technology, and started a competition called the 2004 Grand Challenge. The team whose vehicle that crossed the Mojave Desert the fastest would win a prize sum of $1 million. The first challenge was somewhat of a disaster, but in the subsequent iterations, the vehicles evolved greatly. When Google decided to start its autonomous vehicle project in 2009, many of the team members employed where experienced DARPA challenge participants. (Davis, 2018)

Over the years, many companies have decided to put efforts into developing autonomous cars. Among these companies are automotive manufacturers such as Ford, Tesla, and Volvo, as well as ride-hailing companies such as Uber and Lyft (Davis, 2018). As companies move into the territory of this new technology, there are significant uncertainties regarding the current state of the development of the technology and when fully autonomous cars will arrive. Firstly, companies seem to be eager to be an early mover (Holland, 2018, Hanley, 2019), which might give rise to inflated promises and expectations. Secondly, there is no on/off switch for autonomous cars technology. Contrastingly, it exists on a spectrum. The Society of Automotive Engineers has defined a scale of levels of autonomous driving, from 0 to 5, where 0 represents no present autonomous capabilities of the car, and 5 represents a fully autonomous car (Litman, 2018). The levels in between represent different functionalities that will bring increasing assistance and takeover of control from the human driver. There are cars currently on the market that have driver-assist features of level 1 and 2 (Litman, 2018).

The arrival of fully autonomous cars is likely to incentivize traditional automotive manufacturers to adopt new business models. Arguments to support this hypothesis is the fact that ride-hailing services are developing their own version of the technology, as well as statements made from the CEOs of Tesla and Ford Autonomous Vehicles showing intent from the companies to start their own mobility services (Sherman, 2018, Matousek, 2018, Lambert, 2017). Thus, the future, the car might not be a product that people buy and own. Rather, companies will provide mobility services based on fleets of autonomous cars (Sherman, 2018, Matousek, 2018, Lambert, 2017). In this scenario of shared mobility, traditional car manufacturers face challenges in transforming their businesses (Grosse-Ophoff, Hausler, Heineke, & Möller, 2017). There is an argument to be made that the autonomous technology will disrupt the entire car industry. This would indicate that car manufacturers might need to change their strategy to survive as they will compete with new types of companies. As the technology will free up time for people traveling by car, businesses have the opportunity to exploit this in changing their strategy. Exploring how people will want to spend their time while traveling in an autonomous car can therefore add an interesting and useful perspective for businesses in the industry. Digital platforms are currently providing numerous solutions for work and spare-time related activities that people perform every day. Therefore, it becomes interesting to consider whether a digital platform solution is a viable strategy for companies in the future autonomous car industry to provide a strong offer for their customers.

Ingrid Pettersson, Ph.D and Technical Expert in User Experience methods, has performed research within the area of user experience, abbreviated UX, in future autonomous cars. Pettersson and Karlsson (2015) and Pettersson and Ju (2017) investigate what type of activities people want to undertake when cars are autonomous and identify several categories of wanted activities. As the development of autonomous cars continuedly moves forward and that the research within this field is relatively unexplored, the area of UX in autonomous cars becomes interesting to investigate further.

1.2 Purpose and research questions

The purpose of the paper is dual. Firstly, the aim is to expand on the research of Ingrid Pettersson regarding UX preferences in future autonomous cars. Secondly, it will look at the autonomous car industry of today, how it can be expected to evolve over time and thus what new competitive forces might be present in the future. Furthermore, the research will weave together the findings regarding future UX demands with the probable direction of the industry in terms of competitive forces, in order to uncover possible key success factors in the future autonomous car industry.

The research questions of this paper are:

1. What activities will people want to perform in future fully autonomous cars?
2. Do people have different car preferences for a shared car compared to an owned car?
3. How can autonomous cars change the competitive landscape of the car industry?
4. What can be competitive key success factors in the future autonomous car industry?

1.3 Limitations

This paper assumes that in the future, cars will be fully autonomous, which is a considerable uncertainty that limits the study to a specific future scenario. Furthermore, the empirical part of this study is partly based on a belief that future autonomous cars will be offered as a shared service in the future.

2. Literature framework

In the following sections, a literature framework is presented. These sections have the purpose of being a foundation for the thesis and to explore relevant subjects. In the first part of the literature review, concepts regarding UX, technological change and adoption of new technology is presented. Thereafter follows several sections covering trends in today's car industry, where the relevant ones for this study are identified as autonomous vehicles, connected vehicles and shared mobility. Further, models and frameworks for industry analysis are presented, mainly based on Porter's five forces framework, and the final section relates to literature regarding platform business models.

2.1 User experience

Marc Hassenzahl and Noam Tractinsky (2006) explain how the term User experience is associated with several explanations. Some definitions are only related to the usability aspect while others involve more subjective characteristics such as beauty, design, and feelings. The researchers state that User experience deals with technology that not only fulfills instrumental needs. The User experience of such technology becomes a consequence of a user's needs, expectations and mood, the system's characteristics and the context (Hassenzahl & Tractinsky, 2006).

2.2 Technological change and adoption of innovation

Over the years, many models have been developed to explain and illustrate how technologies emerge and develop and how the market behaves as new technologies and innovations are introduced. Some concepts have been identified as relevant for this study and are presented in the following sections.

2.2.1 Disruptive technology

The concept of disruptive technology was introduced by Clayton. M Christensen. According to Bower and Christensen (1995), a disruptive technology has different performance attributes than the existing technology package. These attributes are not valued by existing customers in the beginning since the performance of standard attributes are not enough. As the technology develops, the performance of the standard attributes gradually improves, and the new technology invades the established market. According to Bower and Christensen, firms often tend to focus so much on the current needs of existing customers, so they do not see the new technology as a threat until it is too late. The classic example used by Clayton. M Christensen was in the disk drive industry when smaller disks were introduced that initially did not have enough capacity for the traditional customers. When the technology improved and the capacity increased, the new smaller disk drives became good enough for the established market while the capacity provided by the larger disk drives were overperforming (Bower and Christensen, 1995).

2.2.2 Diffusion of innovation

According to Rogers (2003), diffusion is the process by which an innovation is communicated between the members of a social system. Rogers describes the process by which the innovation diffuses through the market by dividing the adopters into five customer types based on time of adoption and size of group: innovators, early adopters, early majority, late majority and laggards. According to Rogers, the adoption rate of the innovation can be facilitated by certain attributes. These attributes are observability, trialability, complexity, compatibility and relative advantage (Rogers, 2003).

2.2.3 Moore's law

Moore's law is built on predictions by Gordon E. Moore in 1965 and was transformed into a rule that has had a great impact on the computing industry (Waldrop, 2016). The law is related to a microprocessor chip's performance and states that the number of transistors on a chip will double every two years. This exponential improvement is the reason for the fast development and progress of computers, which have given rise to smartphones, high-speed internet and other product improvements related to the internet of things (Waldrop, 2016).

Ray Kurzweil (2004) extended the theory of Moore's law by including all information technology. Kurzweil states that since technological change is exponential, the returns of the technology will be as well and calls his theory *The law of accelerating returns*.

2.2.4 Technology S-curves

According to Brown (1992), the development of emerging technologies often follows a common pattern, so-called technology s-curves. When a new technology emerges, its performance development is often slow in the beginning, with a relatively high cost for development in time and money. At some point, the technology reaches a critical stage where the performance improves rapidly in relation to cost in time and money. This stage is called the development stage. This stage continues until the technology reaches its inherent limit, whereby the improvements become small even for massive investments in time and money; the technology has reached a mature state. This is illustrated in Figure 1. According to Brown, the highest returns from R&D investments is present in the development stage. Furthermore, Brown states that the companies that often are best situated to exploit a developing technology are the firms that have experience from the emerging technology stage. Such firms can have a competitive advantage in terms of cost-benefit and market presence (Brown, 1992).

Brown (1992) further explains that it is not only in new markets that innovation occurs and has an important role, but innovation can also be an important competitive advantage in mature markets as well. Such innovations, that can cause technological discontinuity can affect the market in such a way that it turns winners into losers. Established firms in mature markets can often miss out on the opportunity to invest in emerging technologies due to their tendency to stay with the technology they know rather than to risk expenditure on new unknown technology (Brown, 1992).

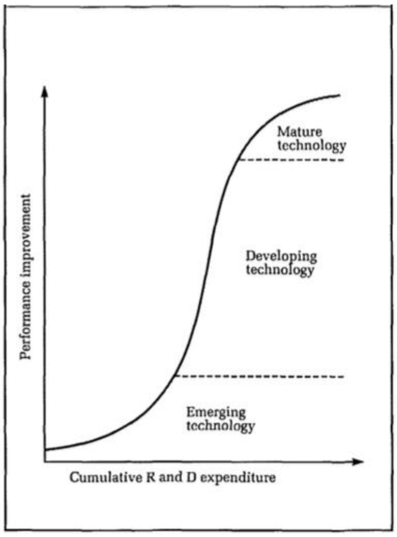


Figure 1. Technology S-curve. Retrieved from Journal of Business & Industrial Marketing, 7(3), 41-52: Managing the "S" curves of innovation. Brown, R. (1992).

2.2.5 Network effects

Positive network effects occur when the consumer experiences greater value of a product with an increasing number of consumers (Katz & Shapiro, 1985). Katz and Shapiro (1985) explain that there exist many products for which the value increases with the number of other users. One such classic example is the telephone. Rysman (2009) states that positive network effects can also be present for two-sided markets. This appears when two agents interact through a platform and the decisions made by each party affect the other. One such example can be a platform for video games, where the consumers and video game developers experience network effects and where the value for one party relies on the other party's behavior (Rysman, 2009).

2.3 Trends in the automotive industry

This section will present trends within the automotive industry, focusing on the developments of the technologies relating to autonomous cars, the adoption of autonomous cars and shared mobility.

2.3.1 Autonomous vehicles

In order to discuss the phenomenon of autonomous vehicles, the concept must first be defined. The US Department of Transportation's National Highway Traffic Safety Administration defines autonomous vehicles as follows: "self-driving vehicles are those in which operation of the vehicle occurs without direct driver input to control the steering, acceleration, and braking and are designed so that the driver is not expected to constantly monitor the roadway while operating in self-driving mode" (NHTSA, 2019). However, whether a vehicle can be viewed as autonomous is not binary. Litman (2018) states that there are five levels of autonomous driving according to the Society of Automobile Engineers;

1. Driver assistance
2. Partial automation
3. Conditional automation
4. High automation
5. Full automation

According to the NHTSA (2019), Level 1 includes some assisting functionalities, while Level 2 incorporates more automated functions such as acceleration. Level 1 and 2 autonomous vehicles still require the driver to be in control of the vehicle and to always observe the surroundings of the vehicle. In Level 3, the driver has to be prepared to take over control from the automated driving system but does not have to be aware of the surroundings at all times. For Level 4 and 5 autonomous driving, the driver is not required to keep track of the environment at all but does have the option to take control of the vehicle if inclined to do so. The difference between Level 4 and 5 is that the highest level of autonomous driving is able to operate all functions of the vehicle under all conditions, while Level 4 is restricted to certain conditions (NHTSA, 2019).

Litman (2018) states that presently, Level 1 and 2 features and functionalities, which can include capabilities such as cruise control and automated parallel parking, are not uncommon in vehicles. Tesla's vehicles do have a feature called "Autopilot", which aside from automated acceleration also includes automated steering. There are many other companies that currently are implementing Level 4 autonomy in different kinds of projects. However, these vehicles cannot yet operate under difficult road conditions, such as in heavy precipitation (Litman, 2018).

Waldrop (2015) uses the autonomous vehicles that Google has developed as an example to describe how the technology works. The author states that autonomous vehicles scan their environment with a combination of radar, laser technology and cameras. The radar is used to notice possible obstacles in proximity to the vehicle, while the laser gives the vehicle a 3D view of the surrounding environment. Cameras are used to spot and identify important objects in traffic such as vehicles, pedestrians and traffic signs. The vehicles are also equipped with a GPS tracking system. The information supplied from the different systems is processed in a computer that makes decisions regarding how the vehicle should behave (Waldrop, 2015). Machine learning is used to enable the vehicle to make the correct decision in each situation it faces (O'Flaherty, 2018). O'Flaherty (2018) states that through machine learning, the vehicle can base its decision upon previous data, which is collected every time the vehicle is driving. Thus, the autonomous vehicle technology becomes better at driving the more driving it has done. Furthermore, O'Flaherty states that this method makes it possible for vehicles to make safer decisions faster than possible for human drivers.

According to Favarò, Eurich and Nader (2018), an important metric that indicates the state and safety of autonomous vehicle technology is the number of miles driven between disengagements. The authors state that a disengagement refers to when a human driver must take over control of the vehicle during testing. Companies that are testing autonomous cars in the state of California are bound to report the number of disengagements each year. A high number of miles between disengagement would indicate a more mature and safe technology, while a low number indicates the opposite (Favarò, Eurich & Nader, 2018).

2.3.2 Connected vehicles

Lu, Cheng, Zhang, Shen and Mark (2014) describe equipping cars with technology that allows for internet connectivity as one of the major factors in the future development of personal vehicles. The authors state that such technology will enable the communication between a vehicle and several other types of units, both internal and external. Vehicle-to-vehicle communication, or V2V, refers to the notion of vehicles in proximity to each other sharing information and can enable the introduction of applications for road safety and entertainment. Another type of communication that could lead to safer road conditions, as well as more commercial applications, is Vehicle-to-road infrastructure; V2R. Examples of the use of V2R could be the communication between a vehicle and street signs, traffic lights or other types of sensors. The final type of communication is vehicle-to-internet, V2I. Bringing together all the mentioned types of communications between a vehicle and its environment constitutes what is called Internet of Vehicles, IoV, which enables the creation of intelligent transport systems (Lu et al., 2014).

Talebpour and Mahmassani (2016) show that a higher market penetration rate of connected vehicles can lead to a higher throughput of traffic in addition to higher traffic stability with lower risks of collisions.

2.3.3 Future adoption of autonomous and connected vehicles

Bansal and Kockelman (2017) present a compilation of findings from other studies regarding the adoption of autonomous vehicles in the future, based on the level of automation. The findings show that there is not a clear consensus regarding when and to what extent different levels of autonomous vehicles will be adopted. However, there are signs that autonomous vehicles of level 4 and 5 will not likely be widely adopted until the 2040s or 2050s (Bansal and Kockelman, 2017). Bansal and Kockelman then perform a statistical analysis of the likelihood of the adoption of different levels of autonomous vehicles based on eight different scenarios. The scenarios are based on different combinations of what the authors call “Willingness to pay” (WTP), a progressive reduction in price for adding an autonomous function and the presence of regulations making it mandatory to incorporate electronic stability control (ESC) and connectivity in new vehicles. In the different scenarios, Willingness to pay is iterated between annual increases of 0%, 5% and 10%, the annual reduction of prices is iterated between 5% and 10%, and regulation is iterated between no regulations and existing regulations. Part of the findings of Bansal and Kockelman’s research regarding the different scenarios are presented in tables 1 and 2.

Scenario	Annual increase in WTP	Annual technology price reduction rate	Regulations
1	0%	10%	No
2	0%, but no zero WTP	10%	No
3	0%, but no zero WTP	5%	Yes
4	0%, but no zero WTP	10%	Yes
5	5%	5%	Yes
6	5%	10%	Yes
7	10%	5%	Yes
8	10%	10%	Yes

Table 1. Parameter values for different scenarios (Bansal and Kockelman, 2017).

Scenario	Adoption of level 4 autonomous vehicles in the US by 2045	Adoption of connectivity in vehicles in the US by 2045
1	43%	59,5%
2	49,8%	83,5%
3	24,8%	100%
4	43,4%	100%
5	43,2%	100%
6	70,7%	100%
7	59,7%	100%
8	87,2%	100%

Table 2. Adoption rate for different scenarios (Bansal and Kockelman, 2017).

The findings of Bansal and Kockelman (2017) show that scenarios 6 and 8 lead to the highest level of adoption of autonomous vehicles in the US by the year 2045. Both have an annual reduction rate of technology price of 10% and the presence of regulations making it mandatory to include ESC and connectivity in cars. Scenario 6 reaches an adoption rate of 70,7% and scenario 8 reaches 87,2%. The difference between the scenarios is the level of increase in the customers' Willingness to pay, as scenarios 6 and 8 have a WTP increase of 5% and 10% respectively. Furthermore, scenarios 1 and 2 show an adoption of connectivity in vehicles that is less than 100%. These two scenarios are the only ones without the presence of regulations for the inclusion of ESC and connectivity in cars. Scenario 3 is that with the lowest future adoption of autonomous cars of 24,8%.

2.3.4 Shared mobility

According to Machado, Salles, Berssaneti, Quintanilha (2018), shared mobility can be explained as transportation alternatives that disconnect the usage of vehicles from the ownership and has the goal to maximize utilization of vehicles in society. Shared mobility should enable the user to get access to a shared vehicle according to the user's needs and convenience. Shared vehicles can help reduce congestion and pollution by the reduction of vehicles in circulation. A private vehicle is parked 95 % of the time on average and the average occupancy rate is below 2 persons per car. Shared mobility can reduce the need for parking spaces and make transportation more efficient. In many countries, shared mobility services introduced by private players have met resistance due to strong government regulations. The advantages of shared vehicles do not just involve sustainability aspects but can also create a higher degree of convenience for the user who can enjoy the benefits of a car without the responsibility and costs of owning it (Machado, Salles, Berssaneti & Quintanilha, 2018).

Grosse-Ophoff, Hausler, Heineke and Möller (2017) estimated the market for shared mobility to $54 billion in 2016, and state that the growth of the market can be expected to reach between 15% and 28% annually until 2030. Yakovlev and Otto (2018) present data that shows that over 50% of over 100,000 respondents claimed that they think that people will adopt shared mobility in the future. The main reason for this was that shared mobility options were viewed as better from a cost perspective. The authors' study also shows that the largest perceived barriers to the adoption of car sharing specifically, defined as a type of car rental, are limited knowledge of existing services and low availability (Yakovlev & Otto, 2018).

Grosse-Ophoff, Hausler, Heineke and Möller (2017) state that 63% of individuals already using ride-hailing services expressed that their usage would increase “a lot” the coming two years.

Gruel and Stanford (2016) discuss a future scenario where all vehicles are shared and autonomous. According to the authors, this scenario would result in fewer cars on the road in total, while increasing the number of trips per car due to a higher utilization ratio. As a result, Vehicle Kilometers Traveled and the volume of traffic would increase. The authors state that the shared model of ownership would bring other interesting effects as well, such as the cost of travel becoming dependent on the supply and demand of trips in a certain region. Essentially, the more trips people take, the cheaper it would become to ride with an autonomous vehicle, increasing the attractiveness of traveling by car. Thus, the cost of travel would be lower in areas with higher population density, which according to Gruel and Stanford could have the effect that densely populated areas would become even more densely populated.

2.3.5 Electric autonomous vehicles

Hatch and Helveston (2018) bring up several arguments for and against whether autonomous vehicles will be electric in the future. They cite the fact that GM has committed to reaching zero emissions in the future, and that Waymo will use electric vehicles to build its fleet of autonomous cars as signs that companies are moving towards electrification. However, they note, Uber will use Volvo cars with combustion engines when developing its autonomous technology, indicating that not all signs are currently pointing to electrification. Additionally, the authors state that the arguments for electrification are the positive effects on the environment, a lower need for maintenance of the vehicles and the fact that electric vehicles will become cheaper to fuel than combustion engine cars. One argument brought up by the authors for why autonomous cars might not be electric in the future is that the computational power required for a fully autonomous car, and thus its energy requirements, will be substantial. Furthermore, building the infrastructure necessary to support electric vehicles will be a challenge. Finally, the authors state that path dependency will have a negative effect on the electrification of autonomous vehicles, claiming that there are many interconnected actors and infrastructure in support of combustion engine cars (Hatch & Helveston, 2018).

2.4 Industry analysis

In the following paragraphs, two frameworks for analyzing an industry will be presented: Porter’s five forces framework and the PEST-analysis framework.

2.4.1 Porter’s five forces

According to Porter (1979), the degree of competition in an industry is decided by five competitive forces: the bargaining power of customers and suppliers, the threat of new entrants, the threat of substitutes and the rivalry between competitors. The competition can range from intense to mild, where profitable industries often are characterized by mild competitive forces and less profitable industries often undergo intense competitive pressure (Porter, 1979). Porter explains that the goal with the industry analysis is for the firm to find a favorable position where it can defend itself from competitive forces or turn them into their favor. Porter’s five competitive forces have been the most widely used framework for analyzing an industry’s competitive landscape and its attractiveness (Grant, 2016). The framework views industry profitability as determined by the collective strength of the competitive pressure, which means that industry attractiveness can be addressed by looking through the lens of Porter's five forces (Grant, 2016). However, Dobbs (2014) brings up that a common misunderstanding of Porter's five forces is that it only addresses the industry attractiveness and profitability. Dobbs explains that the primary purpose of the framework rather is to gain strategic insight into how the firm can compete more effectively in an industry.

Threat of new entry

According to Porter (1979), the threat of new entry to an industry depends on the barriers to entry and the expected reaction from existing competitors when entry occurs. If the new entrant expects high retaliation from the existing firms in the industry and the barriers to entry for the industry are high, the threat of new entry will be low. The expectations on the reaction of existing competitors depend largely on what kind of intentions that are displayed by the incumbents. The incumbents' resources to fight back when entry occurs, and their willingness to cut prices in order to keep market share are examples of such intentions (Porter, 1979).

Porter (1979) further explains how the entry barriers can be divided into six major ones: economies of scale, product differentiation, capital requirements, cost disadvantages independent of size, access to distribution channels and government policy. Existing players at the market can gain economies of scale in different parts of the value chain such as within production, marketing and sales. When economies of scale exist in an industry, new entrants can either enter the industry on a large scale or accept a cost disadvantage compared to the existing competitors. Product differentiation within an industry creates barriers to entry by forcing the new entrants to spend heavily in order to create customer loyalty. Brand identification is an important differentiator and it can be very hard for new entrants to enter an industry where an existing player has a strong brand and loyal customers. Large capital requirements can create a barrier to entry an industry, especially if it concerns uncoverable costs such as large advertisement costs and R&D costs. Cost disadvantages independent of size concerns the fact that existing firms can have cost advantages that are unrelated to their size, which can create entry barriers. This can occur when the existing competitors are facing learning curves or possess government subsidiaries, patents or exclusive access to raw material. The barrier that concerns access to distribution channels deals with the fact that limited wholesale and retail channels often are tied up by existing competitors and that it can be hard for new entrants to take part of the distribution channels. New entrants might then be forced to create their own distribution channels, which create a high barrier to entry an industry. Porter's sixth barrier to entry concerns government policy. This barrier occurs when government limits the entry to industries by controlling means such as license requirements and limited access to raw material (Porter, 1979).

The bargaining power of suppliers

By raising prices or reducing the quality, suppliers can exert bargaining power over firms in the industry (Porter, 1979). If firms cannot raise their own prices towards the customers, this means that the supplier can squeeze the profitability for an industry. The power of suppliers depends on factors such as their level of concentration, the uniqueness of the product they supply, their ability to integrate forward, the industry's importance for the supplier, the importance of the supplier's product for the industry et cetera (Porter, 1979).

The bargaining power of buyers

Like suppliers, customers can exert bargaining power over firms acting in an industry (Porter, 1979). By forcing down prices and demanding higher quality, buyers can squeeze the profitability of an industry. Porter states that several factors determine the relative bargaining power of buyers in an industry, such as product differentiation, the importance of the product for the buyer and the cost of switching to other firms.

Threat of substitutes

According to Porter (1979), substitute products can limit the potential of an industry by reducing its earnings. When customers can switch to an alternative product, the industry needs to differentiate or upgrade the quality of their product in order to protect themselves from competitors. The more attractive the offering from substitute products are in terms of the price-performance tradeoff, the bigger is the threat for the industry (Porter, 1979).

Industry rivalry

The competition within an industry can be in terms of price competition, advertising and product introduction (Porter, 1979). Porter explains that the intensity of the rivalry between existing firms depends on numerous factors such as the number of competitors, how equal they are in terms of size and power, the growth rate of the market, firms' ability to cut prices, excess capacity and exit barriers. In order to protect a firm from high competition from industry rivals, firms can try to increase the switching costs and differentiate their products (Porter, 1979).

Strategy formulation

When the competitive forces of an industry have been assessed and the underlying causes of competition are understood, a firm addresses its strengths and weaknesses and set up a plan for how to compete and position the company (Porter, 1979). According to Porter (1979), this includes to positioning the firm so that its capabilities can meet the competition, improving the position by trying to influence the balance of the forces and trying to exploit change by anticipating the shifts and responding to them. Furthermore, Porter suggests two main competition strategies: cost leadership and differentiation. The first strategy is focusing on offering a product or a service at a lower price than competitors and the later one is focused around how the firm can offer a different product or service that is more attractive than competitors' offerings.

2.4.2 PEST analysis

Grant (2016) explains how the business environment of a company consists off all the external factors that affect its performance and decisions. The core of the business environment consists of the relationship with suppliers, customers and competitors, which can be identified with the use of Porter's five forces. But macro-level factors can also affect an industry a lot. To be able to understand the environmental factors influencing a firm and its business environment, it becomes advantageous to classify them into a system of different sources. The PEST analysis is such a framework where the environmental factors are classified into political, economic, social and technological factors. The PEST analysis is a way to scan macro-level factors affecting the firm. Grant further explains that although the core of a firm's business environment consists of the relationship with customers, suppliers and competitors, it still becomes important to investigate macro trends in order to define threats and opportunities for the future (Grant, 2016). Dockalikova and Klozikova (2014) state that the macro environment analysis has two main functions: to identify the environment within which the firm operates and to help the company anticipate future situations so that they can prepare accordingly.

2.4.3 Key success factors

According to Grant (2016), the five forces framework is a good tool when assessing the potential for profit in an industry. However, the profitability between the firms in an industry often differs more than between industries. In order to understand how the profit is shared among the competitors within an industry, one must look into the sources of competitive advantage. Competitive advantage within an industry is related to its key success factors. The Key success factors in an industry are factors that influence the ability of a company to perform better than its competitors. Grant (2016) presents the process of defining key success factors by looking into the competition of the industry and the customers' preferences, see figure 2. There are two aspects that must be investigated in order to understand an industry's key success factors:

- What does the customer want?
- How does the firm survive competition?

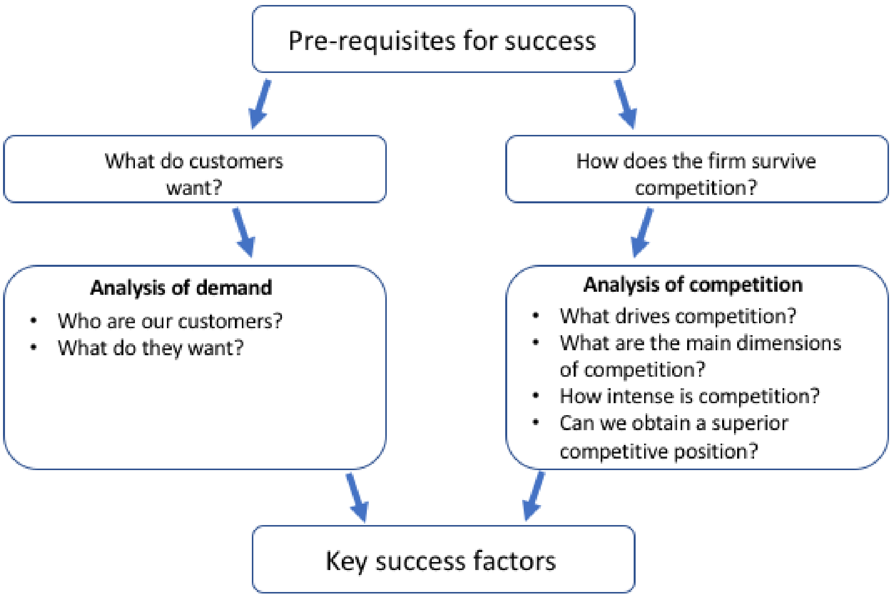


Figure 2. Identifying key success factors (Grant, 2016).

The core of competing successfully is to understand what parameters that are the most important for the customer when choosing between rival offerings. This needs to be combined with the understanding of the key dimensions of the competition within an industry, which can be explored with the use of Porter's five forces. Doing so can give an understanding of the competitive landscape and the bargaining power of suppliers and customers (Grant, 2016).

2.6 Platform business models

Eisenmann, Parker and Van Alstyne (2006) state that some of the most successful products and services have been those that link two groups together. The authors give examples such as the credit card and the gaming console. The former connecting customers with sellers and the latter connecting gamers with game developers. These kinds of systems are called two-sided markets or two-sided networks, and the product or service that enables such a market is called a platform. Eisenmann, Parker and Van Alstyne explain that if a platform is successful, it creates attractiveness between two groups, so-called two-sided network effects.

De Reuver, Sørensen and Basole (2018) discuss the notion of digital platforms. Facebook, Apple's iOS, PayPal and Uber being given as examples of companies providing such platforms. The authors outline the term digital platform as incorporating "various modules that extend the functionality of the software product" (De Reuver, Sørensen & Basole 2018, p. 126). The modules often come in the form of applications provided by third-party developers, which can be used by the end-users. De Reuver, Sørensen and Basole continue by stating that the modularity of digital platforms enabled through the addition of third-party developed applications make products on which digital platforms operate possible to modify after being manufactured. Furthermore, the authors highlight the fact that the nature and architecture of digital platforms have enabled software developers to create applications and functionality to smartphones that were not yet conceived of when the smartphone was developed. One characteristic of digital platforms is that such products and services can be customized after changing user-needs.

3.Market Description

This chapter aims to give a picture of the current state of the autonomous car industry by analyzing the industry according to Porter's five forces (Porter, 1979). Additionally, external factors have been considered in a PEST analysis. Finally, six companies who are currently developing autonomous cars are presented.

3.1 Industry analysis autonomous cars

In the following sections, the current state of the industry of autonomous cars will be presented. Since autonomous vehicle technology is still in a very early stage of development, this industry is seen as equal to the car industry in general.

3.1.1 Porter's five forces of the current car industry

In order to examine the competition in the automotive industry, Porter's five forces as described in section 2.5.1 have been applied.

Threat of new entry

Entering the automotive industry is associated with high capital requirements where the cost of investing in production and distribution networks constitute a large part (Grant, 2016). With the development of autonomous cars, large established automotive manufacturers such as Volvo and Tesla as well as large tech companies such as Google and Apple, are investing a lot in R&D linked to the autonomous technology. To enter the industry with an autonomous car is therefore associated with even higher investment costs. Grant (2016) explains that the industry is characterized by high economies of scale and a high focus on cost efficiency. Furthermore, Grant states that the use of commonly shared platforms among different car models have created economies of scope. Grant further explains that the leading automakers have adopted global models in order to be able to spread the development costs over a larger volume.

Although there are many advantages of being a large player, the industry has remained fragmented, with a four-firm concentration ratio of 39 percent in 2014 (Grant, 2016). Grant explains this by the growth of emerging market car manufacturers, especially Chinese and Indian companies. Globalization has however put high pressure on the smaller manufacturers where they mainly have two options: to join larger automakers by mergers or alliances or by target a niche market segment.

The automotive industry is mature, and the overall growth of the new car market is decreasing. The automotive market has to some extent historically been protected by governments in order to protect the export, this has led to an overcapacity in the industry, which still is present (Grant, 2016). According to Train and Winston (2007) brand loyalty is an important factor when the customer chooses a car, which according to Porter (1979) makes it harder for new firms to enter the industry.

To conclude, the automotive industry is fragmented and associated with high capital requirements, high economies of scale and scope, high brand loyalty and is to some extent protected by governments. In accordance with Porter's five forces (Porter, 1979), this results in that the threat of new entry to the industry is moderately low.

The bargaining power of suppliers

According to Grant (2016), historically, automotive manufacturers have not had close relationships with their suppliers. However, the trend has been progressing towards a closer kind of relationship that is based on more collaboration with long-term ambitions. This has led to a few first-tier suppliers growing to the extent that they rival some automotive manufacturers in size. Additionally, the capabilities of the suppliers have increased in this process (Grant, 2016). Von Corswant and Fredriksson (2002) state that there has been a trend of outsourcing among automotive firms. This trend has led to large portions of important activities no longer reside within the boundaries of the firms, making close collaboration and co-operation with suppliers necessary. Co-ordinating on large scales is costly, therefore automotive firms have sought to reduce the number of suppliers in order to reach more efficient operations. Furthermore, suppliers have increasingly been incorporated into product development as well, which makes the manufacturers more dependent on their suppliers. This further strengthens the trend for automotive manufacturers to focus on a few, strategically important suppliers (Von Corswant & Fredriksson, 2002).

Concluding, the trend of suppliers to automotive manufacturers has been towards higher supplier concentration than before and a higher forward-integration into the processes of the car manufacturers. The suppliers have also become more strategically important to the manufacturers. Thus, in line with Porter’s five forces (Porter, 1979), the bargaining power of suppliers in the automotive industry is at least moderate.

The bargaining power of buyers

When the buyer is small in relation to the supplier, the relative bargaining power of the buyer is weak (Grant, 2016). In the automotive industry, most buyers of cars are individual buyers which indicates that the relative bargaining power of the customer is weak in terms of ability to negotiate the price and put pressure on the automaker. The larger buyers, that buy fleets of cars, have a higher ability to exert influence over the automaker.

The switching costs are low as the buyer can easily switch to another automaker if his/her requirements are not met in terms of design, quality and price. Digitalization has lowered the switching costs further due to its ability to increase the transparency of the market, the customer can easily compare different cars with the use of the internet. According to Chen (2018), switching costs are closely related to network industries and the level of compatibility between networks. Historically, software has not been part of the car but today software has become a key in the development of new cars where the prevalence of connectivity in cars is increasing. This can result in increased perceived switching costs for customers in the future, depending on the compatibility between networks and systems.

A car often constitutes a large expenditure for the customer in relation to his/her income. This, together with the high availability of differently priced options of cars on the market, make the customer price sensitive. The level of differentiation in the industry is relatively high, where firms can differentiate in regard to design, comfort, functionality and digital functions. Firms can create brand loyalty as a differentiation factor that can make the customer more willing to pay a higher price.

To conclude, with the use of Porter's framework (Porter, 1979), the bargaining power of customers can be defined as moderate due to low switching costs, high price sensitivity and high transparency.

Threat of substitutes

There are different kinds of possible substitutes for cars. For long distance travel, trains, buses and airplanes are possible substitutes, while bikes, taxis, ride-hailing services and public transportation are most commonly used for shorter distances. According to Garvill (1999), customers base their choice of mode on cost, travel time, flexibility and comfort. Garvill states that customers ranked the car higher than buses and bicycles on all but the cost aspect while ranking it worse on pollution and energy consumption. However, Garvill explains that for the customers, the outcome for the individual was most often seen as more important than the outcome for society, which meant that customers preferred the car to other substitutes when choosing transportation mode. The trade-off between price and performance is what determines if substitutes constitute threats to the industry (Porter, 1979). In line with Garvill's (1999) findings, the performance of substitutes, although they might be cheaper, cannot compete with the car. Thus, the threat of substitutes is seen as weak.

Industry rivalry

The automotive industry is associated with high fixed costs. These costs include establishing factories, supplier relationships, brands and sales channels. According to Grant (2016), there are high exit barriers in the industry as manufacturers have highly specialized assets. Furthermore, Grant (2016) claims that the industry in its current composition is suffering from excess capacity, which means that the production is outgrowing the demand. The excess capacity leads to higher competition among actors in the industry, not only in the mature markets but in China as well (Grant, 2016). This all leads to fierce competition in the automotive industry, which Holweg (2008) confirms. Holweg states that although the industry is mature, with high entry barriers, competition is still considerable among manufacturers.

3.1.2 PEST analysis

In the following paragraphs, a PEST analysis, as described in section 2.5.2 has been applied to the automotive industry in order to illustrate macro-level factors that might affect the industry.

Political factors

According to Lane, Messer-Betts, Hartmann, Carley, Krause and Graham (2013), governments in several countries are using their power to support the development of electric vehicles. The boost from the government does not only cover research and development within the technology but also the development of supporting infrastructure and systems. The authors explain governmental involvement with two reasons: risk management and industrial policy. Risk management involves the explanation that the government wants to boost electric vehicles to reduce the environmental impact and mitigate the risk of being dependent on oil. Industrial policy is more focused on how the government want to strengthen the country's global position by becoming a dominant market player within a prominent technology (Lane et al., 2013).

The development of autonomous cars has already been supported by governments; one example is that firms developing the technology in the United Kingdom could in 2018 apply for funding of up to £25 million from the Government (Innovate UK & Center for connected and autonomous vehicles, 2018). Maurer, Gerdes, Lenz and Winner (2016) explain that the goal to eliminate traffic injuries by 2050, the so-called "vision zero", is an important selling point for the industry. Ilková and Ilka (2017) state that developers of autonomous technology estimate that traffic fatalities can be reduced by 90% with the use of autonomous cars. Furthermore, the authors explain that the advantages of autonomous cars will go beyond safety. The technology will improve transportation for people with disabilities, the aging population and people who cannot afford a car. Autonomous cars also have the potential to contribute to reduced emissions by efficiency and by supporting the electrification of vehicles (Ilková & Ilka, 2017). Due to the potential benefits to society that will come with autonomous cars, governments' support to the development of the technology and the system around it is likely to continue. Regulations regarding strengthened emission taxes and restricted pollutions are also likely to increase. According to Ilková and Ilka (2017), the legal regulation of autonomous cars is complex but European Union countries are well equipped to be able to meet these challenges due to their legal framework. Adjustments in the legislation will be needed in the future when the technology and the surrounding system is good enough (Ilková & Ilka, 2017).

Economic factors

Ellis, Douglas and Frost (2016) state that the adoption rate of autonomous cars is strongly related to customers' willingness to pay and willingness to use the new technology. Bansal and Kockelman (2017) also point out the importance of willingness to pay among customers when trying to forecast when fully autonomous cars will be adopted. According to Litman (2018), autonomous cars will be more expensive than the cars of today, which makes the willingness to pay a premium for the technology critical, at least in the beginning. Macro-economic factors can have a great impact on people's willingness to pay a premium for autonomous cars. If people's consumption rate decreases for whatever macroeconomic factor, they will have less money dedicated to new cars and new personal vehicles will have lower priority in economic crises. At the same time, one can argue that the shared mobility, if cheaper than owning an own car, can be positively impacted in such a situation; if people decide to sell their car and sign up for a shared service to save money. Furthermore, import taxes protecting the national economy can also affect the industry of autonomous cars. The president of the United States, Donald Trump, has for example proposed 25 percent tariffs on imported automobiles and automotive parts (MBAF, 2018). Those kinds of taxes can pose a big threat for automakers since foreign players will have a hard time penetrating the market.

Social factors

There are current trends of increased environmental concern both on a national level and among citizens that try to change their lifestyle to make more environmentally friendly choices. This increased degree of consciousness of human impact on climate change has resulted in new technologies and solutions within the area of sustainability. Gruel and Stanford (2016) investigate possible outcomes of autonomous cars with regards to traffic volume and congestion, land use and mode choice behavior. They find that autonomous cars in fact can increase traffic volume and congestion if cars are not shared, in addition to the fact that people might use the car more due to the convenience the autonomous car brings. If autonomous cars instead will be shared among citizens, the traffic volume and congestion can decrease. The outcome will depend on the behavioral changes among people when autonomous cars are introduced (Gruel & Stanford, 2016). The adoption and acceptance of shared autonomous cars will therefore be critical when it comes to how autonomous cars might impact traffic volume and congestion. Furthermore, the fact that companies like Airbnb and Uber have been widely spread and successful can be seen as a trend of growing interest and acceptance of a shared economy.

Technological factors

According to Anderson, Nidhi and Stanley (2014), many stakeholders anticipate that the first commercially available autonomous cars will not be fully autonomous, but rather able to drive without assistance under certain operating conditions. Such conditions can be under special speed limits and on special roads. The person also needs to be prepared to act if the car requests help. The authors state that this human driver reengagement will become a key challenge. The most prominent benefit of autonomous cars is that the human does not need to concentrate on driving but can do other activities while traveling. However, if the human needs to be able to rearrange in a matter of seconds for safety, the advantage of the autonomous technology will decrease a lot (Anderson, Nidhi & Stanley, 2014).

Nykvist and Nilsson (2015) show in their study that the cost for producing an electric vehicle has decreased steadily since 2005, and that it by 2014 probably had fallen below projections for production costs estimated for 2020. They state that it is likely that production costs for market-leading actors in 2014 were as low as $300 per kWh and that in the coming years this figure can be expected to drop significantly due to investments in development and manufacturing. In their paper, Nykvist and Nilsson also claim that electric vehicles will become widespread when costs fall lower than $150 per kWh. Nienaber, Taylor, Schwartz, Vaish and Felix (2018) report that many car manufacturers are beginning to establish collaborations with manufacturers of batteries for electric cars. This in order to develop and manufacture the batteries for the car companies' vehicles as they are putting effort into advancing their electric vehicle technology.

3.2 Companies developing autonomous cars

The California Department of Motor Vehicles provides a full list of companies currently permitted to test autonomous cars in California, which was last updated on January 28th, 2019 and includes 62 companies (State of California Department of Motor Vehicles, 2019a). Only one company is permitted to perform tests without a driver; Waymo, LLC (State of California Department of Motor Vehicles, 2019b). December 20th, 2018, it was reported that Uber would be able to resume testing of its autonomous cars in Pennsylvania after a hiatus that came after a deadly accident in March that same year (Shepardson, 2018a). According to Vaish (2019), Volvo Cars was in September 2018 granted permission to perform autonomous vehicle testing in Sweden under certain conditions. A joint venture formed between Volvo Cars and Veoneer called Zenuity was in January 2019 also approved for testing (Vaish, 2019).

A selection of the abovementioned companies has been made to represent the industry of autonomous cars and its development. The selected companies have been divided into two categories based on whether the companies manufacture cars or not; car manufacturers and ride-hailing service providers.

3.2.3 Car manufacturers

Ford Motor Company

Ford was founded in 1903. The company's first successful car called the Model T was introduced in 1908, which reached 500 000 accumulated units sold by 1914 (Encyclopedia Britannica, inc., 2019). In 2018, Ford's brand was valued as the fourth most valuable car brand in the world with a brand value of $12.74 billion, placing the company behind Toyota, Mercedes-Benz and BMW (Statista, 2019). Ford has plans of launching level 4 autonomous cars in 2021, which subsequently will go into mass-production. According to the company, the vehicles will not include a steering wheel or pedals in its design (Ford Motor Company, 2019). In an interview in 2018, the CEO of Ford Autonomous Vehicles, Sherif Marakby, stated that the goal is to launch a mobility service around the autonomous vehicle technology and that the company has committed to invest $4 billion in the development of the technology up until 2024 (Holland, 2018). The fact that the company is looking towards moving into the mobility service market likely means that it will face new types of competitors in companies such as Uber and Lyft (Sherman, 2018).

Tesla, Inc

In 2003, Tesla was founded with the mission of producing electric vehicles for an affordable price, in order to make clean transportation available to the masses. The company states that its vision is to reach a future with zero emissions as soon as possible. Three car models are currently available to buy from Tesla, the Model S, Model X and Model 3. Additionally, the company offers an electric truck called the Tesla Semi (Tesla, 2019a).

According to Tesla, all the company's vehicles are equipped with the hardware necessary to enable full self-driving. The company does not define at what level of autonomous driving this represents, but it is stated that the vehicles are equipped with hardware to handle self-driving in "almost all circumstances" (Tesla, 2019b). In February 2019, the company's CEO and co-founder Elon Musk stated during a podcast that full self-driving would be available in Tesla's vehicles in 2019. However, indications during the interview point to that this would not mean level 5 autonomous driving, but level 4. Continuing, Musk expressed hopes that Tesla's self-driving vehicles would be safe enough that the human driver could fall asleep during transportation and wake up safely at their destination "probably towards the end of next year", referring to the end of 2020 (Hanley, 2019). Simultaneously, Tesla's vehicles performing self-driving under what the company calls Autopilot mode, have been involved in several recent crashes, with at least one casualty (Dobush, 2018, Saplakoglu, 2018, Shepardson, 2018b).

Tesla has plans to introduce a mobility service, which Elon Musk in the company's first-quarter earnings call for 2018 stated would probably be ready for use by the end of 2019 (Matousek, 2018). According to Matousek (2018), the service will be called Tesla Network, and Musk claimed that the mobility service would be somewhat of a mix between a car-sharing and ride-hailing service, meaning that Tesla owners will be able to connect their cars to the network. The privately-owned cars would then be accessible for other people to borrow until the car's owner requests for the vehicle to be recalled (Matousek, 2018). According to Lambert (2017), Musk has previously stated that the Tesla Network in the future will provide fully autonomous shared rides as the company's vehicles will become autonomous.

In its report to the California DMV regarding the testing of the company's autonomous cars, a representative of Tesla states that the company did not test its vehicles "as defined by California law". Instead, it is stated that the autonomous technology is tested by the company's customer who uses the technology every day. The numbers presented in the report show that these customers recorded one crash per 1.92 million miles driven and that while in autonomous mode the cars recorded one crash per 3.34 miles driven (Prescott, 2018).

Apple

In 2015, it was reported that Apple was looking into developing a self-driving electric car. The company did not seem to seek to establish partnerships with established automakers, but rather to design and produce a new vehicle from the ground up (Taylor & Oreskovic, 2015). In August of 2018, a former Tesla executive responsible for engineering and production joined Apple, to work on its self-driving car project, called Project Titan. The project seems to involve efforts to bring innovative solutions to the design of the personal vehicle, with patents filed for what seems to be an augmented-reality windshield and rumors of spherical wheels being developed. In 2018, Apple had 66 autonomous cars being tested on roads in California (Stangel, 2018).

In January 2019, 200 engineers working on Project Titan were cut from the project, according to CNBC. CNBC simultaneously reported rumors that the project has shifted focus from developing a completely new vehicle to only self-driving software (Kolodny, Farr & Eisenstein, 2019). Apple's autonomous cars had driven about one mile between disengagement during 2018 (Nellis & Sage, 2019). This can be compared to Waymo's corresponding number of 11 017 miles, see section 3.2.4.

3.2.4 Ride-hailing services

According to Feng, Kong and Wang (2017), the use of ride-hailing platforms, which connect private drivers with passengers through smart-phones, have grown considerably in the last years. For instance, in 2016, Uber reached the milestone of 2 billion rides through its platform (Feng, Kong & Wang, 2017). Clewlow and Mishra (2017) state that estimations show that this kind of ride-hailing service grew to reach 250 million users within the first five years.

Uber

Uber connects drivers with passengers. Communication, payment and navigation are all performed in the app where passengers and drivers can give feedback and rate each other after each ride (Uber, 2019a).

Uber is currently developing autonomous vehicle technology for its shared mobility offering, stating that if successful, the technology can help make transportation safer and more affordable than today (Uber, 2019b). According to Uber, the company uses a "vehicle platform", which is modified in order to support autonomous driving (Uber, 2019c). The vehicle in question is the Volvo XC90s, which the company has chosen due to its level of safety. Uber retrofits the XC90 with both hardware and software to enable autonomous driving of the vehicle. The case made by the company to go towards autonomous drive is that it has the potential to increase the safety of the rides in addition to cost- and time-efficiency. It can help clear space currently used for parking and combined with sharing rides it can help decrease the number of vehicles in use, making society more sustainable. (Uber ATG Safety Report, 2018).

Between March 8, 2017, and November 30, 2018, Uber reported 26 889 miles driven while testing its autonomous cars, and 70 165 total disengagements to the California DMV (Meyhofer, 2018). This is equal to one disengagement for just under every 0,4 miles driven.

Waymo LLC

Waymo started as an autonomous vehicle project at Google in 2009. The project began with adding hard- and software as an aftermarket solution to cars from Toyota and Lexus. In 2015 experiments were made with a custom-made autonomous car called Firefly, which was eventually canceled. Later, in 2016, the company Waymo was founded as under Alphabet, Google's mother company. A model from Chrysler was added to Waymo's fleet in 2017. Currently, the company is performing testing of its autonomous cars without anyone in the driver's seat (Waymo, 2019a).

Looking ahead, Waymo has stated that it will add 20 000 vehicles to its fleet, of a model called the I-PACE, manufactured by Jaguar (Waymo, 2019b). Waymo's stated mission is focused on the safety and ease of mobility, claiming that 94% of car crashes in the US are due to human error (Waymo, 2019c). It has started an early rider program in Phoenix, where customers can use the company's autonomous cars for transportation (Waymo, 2019d).

Waymo is currently leading in the industry, with over 10 million testing miles of its autonomous cars logged. In 2018, Waymo was the industry leader with 11 017 miles driven by the autonomous system between disengagement (Nellis & Sage, 2019).

Lyft, Inc.

Lyft is a ride-hailing company, connecting drivers and passengers through their app, operating in North America (Lyft, 2019a). The company is currently developing an autonomous vehicle system meant for ridesharing (Lyft, 2019b). According to Somerville (2018), in August 2018, Lyft had amassed over 5000 autonomous rides, as passengers in Las Vegas can utilize an autonomous BMW. Uber, which is also involved in testing autonomous vehicle technology, is Lyft's primary rival (Somerville, 2018).

4. Methodology

In the following sections, the methodology and process of the study are presented and motivated. In order to answer the research questions, the study has been divided into different steps.

4.1 Research strategy and design

According to Saunders, Lewis and Thornhill (2016), theory can be developed in three ways; through deductive, inductive or abductive research. Deductive research takes its starting point in a hypothesis for a theory that is to be tested. Inductive research, oppositely, is used in generating theory. The inductive approach is most favorably used in social research, as it is better suited to reach alternative explanations in contrast to the rigid methodology of deductive methods. In this type of research, data collection and observations are made, which in turn give rise to new, untested conclusions (Saunders, Lewis & Thornhill, 2016). The data collection is performed in an exploratory way, with the purpose of exposing patterns, which in turn can lead to the development of conceptual frameworks (Saunders, Lewis & Thornhill, 2016). The research of this study adopts an inductive approach, where exploratory methods are used in order to give rise to new conclusions and insights.

According to Bryman and Bell (2014), the research approach can be divided into being qualitative or quantitative in its nature. A qualitative approach is more explorative and usually focuses on the collection and analysis of non-numerical data such as words, observations and pictures. Furthermore, qualitative methods adopt an inductive research approach with a focus on generating theory from collected data. Commonly used qualitative methods include qualitative interviews, open-ended surveys and discussions in focus groups. Quantitative research has a more deductive approach where the quantification of data often is used to empirically test theory (Bryman & Bell, 2014). In this study, a qualitative research approach was used due to the explorative nature of the study. Semi-structured interviews with open-ended questions were decided as suitable.

4.2 Research Process

The research process was divided into sub-steps and followed an iterative process, see figure 3. The first steps had the purpose of giving an understanding of the subject and collect relevant information from previous research. Therefore, the research process started with the conduction of a literature framework. The aim of the literature framework was to gain insight into previous research within the area of user experience in autonomous cars as well as into the autonomous vehicle technology and its development and adoption. Furthermore, relevant information regarding digital platforms were processed and presented in the literature framework. Simultaneously, a description of the market of autonomous cars was developed, where a closer look was taken on firms that have taken the lead in the development and adoption of autonomous vehicle technology. In order to explore the competitive landscape of the current car industry, an industry analysis was performed.

The empirical part of the study consisted of interviews with future possible users of autonomous cars with the purpose of gaining an understanding of what people want to do when riding in autonomous cars in the future. Furthermore, with the use of Porter's five forces framework and a PEST-analysis, an industry analysis on the future autonomous car industry was performed. The findings from the interviews, together with the future industry analysis, were analyzed and processed into key success factors, in line with the process of identifying key success factors presented by Grant (2016).

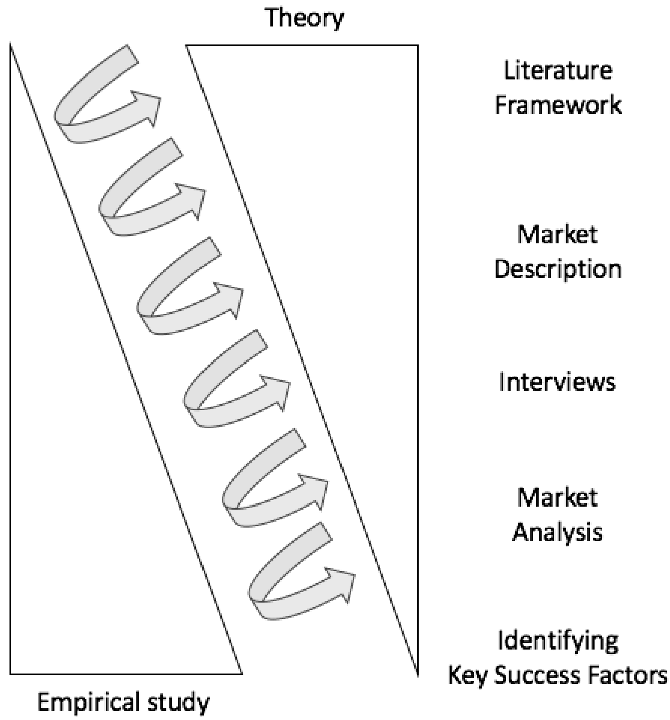


Figure 3. The process of the research and its different steps.

4.2.1 Literature review

Easterby-Smith, Thorpe and Jackson (2015) divide literature reviews into two different types: the traditional literature reviews and the systematic literature reviews. A traditional literature review summarizes literature mainly based on what the reviewer chose to be the most relevant and interesting sources. A systematic literature review is more methodical in the way sources are collected and evaluated. Often such literature reviews are collected and evaluated based on strict criteria that have been decided beforehand (Easterby-Smith, Thorpe and Jackson, 2015). The literature review conducted for this research has followed a traditional process, where keywords have been used to find relevant literature. The selection of literature has not followed strict criteria. However, only peer-reviewed articles have been cited in order to ensure quality and trustworthiness. Articles that have been cited to a high extent have also been selected to a larger extent than those not being cited.

4.2.2 Market description

A market description for autonomous cars was performed in order to gain an understanding of the current market and its players. The market was explored by looking deeper into which companies that are trying to adopt the technology into their current business models and which companies that are leading the development of the technology. Due to the relative novelty of the technology in combination with the fact that the market is in a phase of continuous change, scientific articles became less relevant and often obsolete. Therefore, data used were collected from companies' web sites, news articles and media.

An industry analysis was performed in order to analyze the current industry of autonomous cars. Since the technology is novel and is not yet launched for private use, the industry was decided to be the same as today's automotive industry. The industry analysis was based on a Porter's five forces analysis (Porter, 1979) and a PEST-analysis.

4.2.3 Empirical part

The purpose of the user experience interviews was twofold, the first session of the interviews aimed to collect data regarding what people want to do in fully autonomous cars in the future. The method used was based on the method and research by Pettersson and Karlsson (2015). Their method "Setting the stage" has a qualitative approach that has been developed in order to give the participants good conditions for expressing future needs and wants. The interviews were based upon results from the research by Pettersson and Karlsson (2015) and Pettersson and Ju (2017).

The second part of the interviews focused on exploring how users' car preferences might change when the ownership model changes towards a shared service.

4.2.4 Analysis/discussion

The results from the user experience interviews were analyzed and presented in order to discuss what the customer will demand in terms of user experience. An industry analysis of the future autonomous car industry was then performed in order to understand how the industry can come to change in the future. This analysis was performed with the use of Porter's five forces framework (Porter, 1979) and the trends that had been presented in the literature framework and the market description. Finally, the result from the industry analysis together with the result from the user experience interviews were used to identify a set of key success factors.

4.3 Empirical Data

The empirical study of this thesis has mainly been based on research done by Pettersson and Karlsson (2015) and Pettersson and Ju (2017). In the following sections, the work of these researchers will be presented as well as the data collection and data analysis of this study.

4.3.1 Previous research within the area of user experience in future autonomous cars

According to Pettersson (2017), prospective user research can be beneficial when investigating future use of a product that does not yet exist and does not have any predecessors. If a product can disrupt former needs and context of use, it becomes less relevant to examine past experiences. However, Pettersson further explains that it can be difficult to examine people's expectations of novel products due to the challenge of imagining products that do not yet exist. Moreover, it becomes a challenge for participants in such studies to not being affected by existing designs and products while expressing the needs and wants of the future design (Pettersson, 2017). If a person should express wants and needs of autonomous cars in the future, while sitting in an existing car model, the focus will mainly be about today's issues (Pettersson & Karlsson, 2015). To support the creative process in such a study, it can be easier for participants to draw their needs and wants instead of just using words (Pettersson, 2017).

Within the area of user research, techniques typically used are interviews, observations and questionnaires/surveys (Pettersson & Karlsson, 2015). The disadvantage with such techniques is that it can be challenging for the researcher to gain an understanding behind the responses. To use more qualitative studies can give a better understanding of the participant's feelings and expectations. Pettersson and Karlsson examine the user experience of future autonomous cars with their method "Setting the stage" (2015). The method has a qualitative approach where the participants get an active role. The method consists of two studies, referred to as study A and Study B in table 3. In study A, the participants draw and collage their vision of autonomous cars. In study B, the participants need to imagine the autonomous car in a setting built up by four chairs placed at a parking spot, with a car drawn with chalks at the ground. The participants could then redesign the area by using the chalks and moving around the chairs. Pettersson and Karlsson point out the importance of the participants still being situated in their own lives, so they express needs and wants based on their own actual needs. Before the studies, the researchers therefore first ask the participants about their current daily commuting trips, in order to set the participant in the mindset of his/her life situation. In table 3, the result from Pettersson's and Karlsson's studies regarding what type of activities people want to undertake in future autonomous cars are presented.

In the paper by Pettersson and Ju (2017), the researchers discuss emerging trends in human-vehicle interaction and find types of activities that the passenger wants to perform, associated with using the car as a personal space. Examples of such activities are within the categories of health, sleeping and self-development.

Activities	
Study A	**Study B**
Relaxation	Relaxation
Working	Working (lighter work tasks)
Sleeping	Sleeping
Reading	Reading
Socializing	Socializing
Eating	Video entertainment
Tending to children	Games
Drinkig alcohol	Using social media
Video entertainment	

Table 3. Results from Pettersson's and Karlsson's research (2015).

4.3.2 Data collection

As stated previously, the method used in the collection of qualitative data regarding future user experience in autonomous cars was based on methods used by Pettersson and Karlsson (2015). In their article *Setting the stage for autonomous cars: a pilot study of future autonomous driving experiences*, Pettersson and Karlsson find several activity types that the candidates of the study express they want to perform in future autonomous cars. Furthermore, Pettersson and Ju (2017) find similar expressed activity types in their study of autonomous cars. Six of these activity types/categories were selected to be investigated further in this study. The categories were chosen in such a way that they would cover as many activities as possible while avoiding overlapping. The categories chosen were: Relaxation, Entertainment, Health, Socialization, Working, Learning.

Nine candidates were asked to participate in the study. The candidates were not chosen randomly but based on different criteria. Eight out of nine candidates were between the age of 20-30. This age interval was chosen with the motive to grasp thoughts from people that are most likely to use the technology in the future. One candidate was in the age of 50-60, this person was chosen to participate in the study in order to also get perspective from an older person. Moreover, candidates were chosen based on their commuting habits, car ownership, gender and profession, where the aim was to collect a diversified group of candidates in regards to these parameters. See table 4.

Gender	Age	Profession	Drivers' license	Car owner
Female	26	Student	Yes	No
Male	29	Engineer	Yes	No
Female	52	Project manager	Yes	Yes
Male	28	Engineer	Yes	Yes
Female	29	Engineer	Yes	Yes
Female	27	Teacher	No	No
Male	28	Doctor	Yes	Yes
Male	28	Tradesman	Yes	No
Male	23	Factory worker	Yes	Yes

Table 4. Information regarding interviewees

The collection of data was a mix of qualitative interviews and a more creative part where the candidate's task was to make a collage in order to express wants and needs in autonomous cars. The session started with some questions regarding the interviewee's everyday-life, routines and commuting habits with the purpose of getting the person into the right mindset for the collage session. This was done since it was important that the candidate expressed his/her own needs and wants and originated from his/her life, in line with the reasoning of Pettersson and Karlsson (2015). Following these questions, the candidate was given six papers and was instructed to make six collages where he/she expressed what they want to do in a future autonomous car, based on the six categories. The candidate could both draw and write to express himself/herself on the collage. When the candidate was finished, he/she was asked to explain what was on the collage and reflect upon what he/she needed in order to perform the activity, in terms of hardware and software. Furthermore, the candidates were asked questions regarding their willingness to pay more for an autonomous car compared to a non-autonomous car, in order to explore aspects that are necessary for the adoption of autonomous cars as discussed by Bansal and Kockelman (2017) and Litman (2018).

The last part of the session consisted of qualitative interviews with regards to the candidates' preferences and criteria when buying a car compared to when using a shared service. The purpose of this was to investigate the possible differences in people's preferences with regards to shared cars compared to owned cars. The candidate was first asked to list her/his preferences when she/he was about to buy a car. Thereafter, she/he was asked about his/her preferences if the car was shared with other people. The candidates were also asked if they saw any problems with performing the activities they had described before if the car was shared among many people.

4.3.3 Data analysis

The result from the interviews regarding activities in the car was analyzed by clustering all answers into different activities. If a candidate said he/she wanted to watch Netflix and another candidate wanted to watch a movie or a football game, these were all sorted into the activity watching tv/movies/series. This was done for each category separately. If a candidate had drawn or painted the same activity for two categories, this activity was included in both categories. For every activity within a category, the total number of times an activity had been mentioned was counted and registered. Furthermore, the candidates' answers regarding what type of equipment needed for each activity was compiled. The answers regarding willingness to pay extra for an autonomous car was also summarized.

The result from the interviews regarding car preferences for shared and owned cars was in a similar way clustered into different categories, such as "Safety", "Design/Color" and "Comfort". The result was compiled by counting all car preferences for an owned car and a shared car, in order to see the difference between the two.

4.4 Quality of research and reflections

Easterby-Smith, Thorpe and Jackson (2015) explain how the validity of a study is dependent on factors such as the number of persons included and how well the study gains access to the persons' actual experiences. Nine persons participated in this study. The relatively low number of participants were decided based on the limited amount of time and the complexity and time consumption of the interview sessions. The persons chosen were mostly young adults, since those are the persons that are most likely to use the autonomous car in the future. However, by not including more people from the older population, needs and behaviors that are specific for this generation might be missed out. Additionally, all interviewees are from the Swedish middle class, which might further affect the results. Furthermore, there might be a risk of people having a hard time expressing and knowing their future needs and wants. There can also be a risk the interviewees not feeling comfortable expressing personal or sensitive information.

According to Easterby-Smith, Thorpe and Jackson (2015), the reliability of the study is related to the likelihood of reaching similar observations by other researchers. Since the character of the methodology used in this study is highly qualitative and the subject complex, the risk of affecting the participants exist. How the interviewer explains the task and provides help with clarifying concepts during the exercise, in order to get the participant going, might affect the interviewee. In order to reach a higher level of reliability, an appendix with an in-depth description of the interviews is presented.

The generalizability is the ability to use the study to draw general conclusions in other contexts (Easterby-Smith, Thorpe and Jackson, 2015). Due to the relatively low number of participants in this study, and the complexity of the subject, the generalizability of this study is relatively low.

The autonomous vehicle technology has been identified in both media and science as having the potential to transform the car industry. Due to this, it might be a strategical move for some firms to express an optimistic view of their development. This should be considered when statements expressed from firms regarding their advancement are presented.

5. Empirical findings

In the following sections, the result from the interviews is presented.

5.1 User Experience Interviews

The user experience interviews were performed regarding two aspects of the future use of autonomous cars; the user experience in terms of what the interviewees will want to do when riding in a fully autonomous car, and what the interviewees value in an owned car compared to a shared car. See Appendix B to view examples of collages drawn during the first phase of the interviews.

5.1.1 Activities in car

As table 5 shows, there is a clear difference in the number of total mentioned activities between the different categories. In this context, the number of unique activities refers to the activities mentioned within a category regardless of how many interviewees that mentioned that activity. The number of total mentions counts each time an activity was given as an answer. For example, in the category Relaxation, the activity "Watching tv/movie/series" was mentioned by five interviewees, while the activity "Meditation" was mentioned by one. Both counts as one unique activity each, while the first gives five counts of total mentions and the latter only one.

Activity category	Number of unique activities	Number of total mentions
Relaxation	10	29
Entertainment	8	28
Socializing	8	24
Health	7	18
Learning	6	17
Working	5	23

Table 5. Result regarding activities within each category.

Some activities are recurring across categories. Watching tv/movies/series was mentioned in Relaxation, Entertainment and Socializing. Having food and drinks was mentioned as an activity in Relaxation, Entertainment and Health, in addition to the fact that alcohol was mentioned as part of a Socializing activity. Some of the interviewees stated that they would like to have a fridge with food and drinks available in the car, while others wanted to bring their own food and drinks with them. Listen to music and podcasts was mentioned as an activity in Relaxation and Entertainment as well as being part of activities in Socializing and Learning. Meditation came up as activities in both Relaxation and Health. Another aspect mentioned within Relaxation, Entertainment and Socialization was the need for comfort. Several interviewees stated that they wanted some kind of sofa so that they could feel more at ease and comfortable than when riding in an ordinary, contemporary car.

Within each activity mentioned, the interviewees mentioned specific solutions that they use for that purpose today. Several different solutions were mentioned in many activities. For example, in the “Watching tv/series/movies” activity, the solutions mentioned were Netflix, Cmore, HBO and YouTube. For playing games online, both computers and consoles such as PlayStation 4 were given as examples.

During several interviews and by several interviewees the concept that will be called Environmental Experiences was brought up and discussed. In these discussions, the notion of having either VR technology or some sort of screen on the inside of the windows of the car were proposed as means to make the passenger feel like they are in another environment. For instance, one interviewee stated that he would like to feel as he was going on a safari, riding a car through a jungle or driving on the north pole. Another interviewee that discussed this notion stated that it would be a good way to wind down by getting the feeling of leaving his ordinary life for a moment, and gave the example of using either VR technology or windows as screens to make him feel like he was driving a race car. Environmental Experiences were mentioned in both Relaxation and Entertainment.

Some interviewees came up with most wants and needs within the categories Relaxation and Entertainment and stated that they would see the time spent riding in an autonomous car as dedicated to calming down and unwinding. Other candidates mentioned more activities for the Working category since they valued the opportunities of being productive. Some interviewees wanted to undertake working activities while traveling to work, while stating that riding home in an autonomous car after work could be spent relaxing. Related to the Working category, some interviewees raised concerns regarding security, especially if the car was to be shared and not owned.

Three interviewees mentioned the idea of a concept that purports that some shared autonomous cars could be designed for very specific purposes. In this context, the interviewees discussed the fact that they wanted to be able to do some things that are done quite seldom, but that would save them time in their life puzzle. For example, such cars were proposed as being equipped with medical equipment and even doctors, so that passengers could be given physical exams while going to work. One interviewee stated that some cars could come with pets such as dogs and cats so that she could wind down by spending time with animals. The idea was raised that a small number of shared autonomous cars in a fleet could be specially equipped in such sense.

Furthermore, some interviewees mentioned that they would like to use the time spent in the car with activities involving other people. Related to the Working category this could be to have a job meeting while going to a conference. Related to the category Learning an interviewee mentioned he would like to improve his Spanish skills by riding with other people with the same goal.

Table 6 displays the number of mentions for each activity within each category in a color-coded fashion. If an activity has more than one mention, this means that the activity was mentioned by more than one interviewee within the same category.

Relaxation	
Activity	**Number of mentions**
Watching tv/movies/series	5
Spa	5
Music/Podcast	5
Food and drinks	5
Sleeping	3
Environmental Experiences (feel like you are someplace else)	2
Meditation	1
Planning	1
Makeup, manicure	1
Phone calls to family	1

Entertainment	
Activity	**Number of mentions**
Watch movies/series/tv/youtube	7
Listen to music, podcast and audio books	6
Playing online games	5
Food and drinks	3
Environmental Experiences (feel like you are someplace else)	3
Playing physical games	2
Surfing the web and doing e-shopping, social media etc	1
Spending time with cats and dogs	1

Socializing	
Activity	**Number of mentions**
Making phone calls	7
Hanging out with friends in the car	6
Riding with others to social activities/parties	4
Playing games with others	2
Playing games and socializing online	2
Meet new people with shared interests	1
Watch tv/movies/series together	1
Social media	1

Health	
Activity	**Number of mentions**
Massage, rehabilitation, stretching	4
Physical exercise	3
Physical examination by a doctor	3
Food and drinks, especially before and after exercise	3
Body scan to find out vital signs	3
Mental training and meditation	1
Relaxing	1

Learning	
Activity	**Number of mentions**
Learn new things, Classes, lectures with different themes	8
Listening to podcasts/books	3
Studying	2
Develop language skills with others	2
Watching documentaries	1
Focusing	1

Working	
Activity	**Number of mentions**
Job meeting online	6
Job calls	6
Working	6
Physically job meetings	4
Car can collect material (Craftsman)	1

Table 6. Result from each category.

Table 7 displays each category, the activities mentioned within each category and the equipment mentioned as necessary to perform each activity. A lot of the necessary equipment are recurring between different categories, such as screens, VR technology, internet connection, apps and loudspeakers, while some equipment is less frequently mentioned.

Relaxation	
Activity	**Necessary equipment**
Watching tv/movies/series	Screen, internet connection, access to apps
Spa	Massage chairs, music, relaxing lightning, foot bath
Music/Podcast	Loudspeakers, access to pods/music in iphone, apps
Food and drinks	Fridge with food, drinks, alcohol
Sleeping	Sofa, Space for comfortable position
Environmental Experiences (feel like you are someplace else)	VR tech, windows as screens, sound system, good supply of environments, apps
Meditation	Loudspeakers, windows as screens, VR tech, blacking out light, access to apps
Planning	Space for computer, notepad etc
Makeup, manicure	Table, mirror
Phone calls to family	Loudspeakers connected to phone, sound proof

Entertainment	
Activity	**Necessary equipment**
Watch movies/series/tv/youtube	Screen, internet connection, access to apps
Listen to music, podcast and audio books	Soundsystem, internet connection, access to apps
Playing online games	VR tech, gaming consoles, computers, LAN connection, internet connection
Food and drinks	Fridge, bar, table, plates, cutlery
Environmental Experiences (feel like you are someplace else)	VR tech, windows as screens, sound system, apps
Playing physical games	Board games, table hockey, shuffle board etc
Surfing the web and doing e-shopping, social media etc	Screen, internet connection, access to apps
Spending time with cats and dogs	A special car equipped with cats and dogs to cuddle with

Socializing	
Activity	**Necessary equipment**
Making phone calls	Loudspeakers connected to phone, sound proof
Hanging out with friends in the car	Screen, music, sofas, table
Riding with others to social activities/parties	Alcohol, sofas, table, music
Playing games with others	Sofas, computers, gaming consoles, wifi,
Playing games and socializing online	Skype, VR technology, wifi, computers, gaming consoles
Meet new people with shared interests	Ride-sharing
Watch tv/movies/series together	Screen, internet connection, access to apps
Social media	Internet access, apps

Health	
Activity	**Necessary equipment**
Massage, rehabilitation, stretching	Massage chair, stretching and rehab equipment
Physical exercise	Treadmill, gym equipment, yoga mats, apps
Physical examination by a doctor	A car especially for doctors appointments, with a physician onboard
Food and drinks, especially before and after exercise	Fridge, food, drinks
Body scan to find out vital signs	Scale, pulse detector etc
Mental training and meditation	Apps, internet connection, ability to drown out light and noises from outside
Relaxing	Sofa, space for comfortable position

Learning	
Activity	**Necessary equipment**
Classes, lectures	Screen, internet connection, soundsystem, masterclass-apps, access to apps, access to online lectures
Listening to podcasts/books	Sound system, internet connection, apps
Studying	Chairs, table, computer, internet connection, apps
Develop language skills with others	Chairs, table, computer, internet connection, apps
Watching documentaries	Screen, sound system, internet connection, apps
Focusing	Turning off all entertainment equipment so it's easier to concentrate

Working	
Activity	**Necessary equipment**
Job meeting online	Skype, computers, VR, screen
Job calls	Loudspeakers connected to phone, sound proof
Working	Computer, internet connection, access to work system, privacy is very important
Physically job meetings	Ride-sharing, screen, computers, wifi
Car can collect material (Craftsman)	Enough space for material and tools

Table 7. Activities mentioned in each category and mentioned necessary equipment.

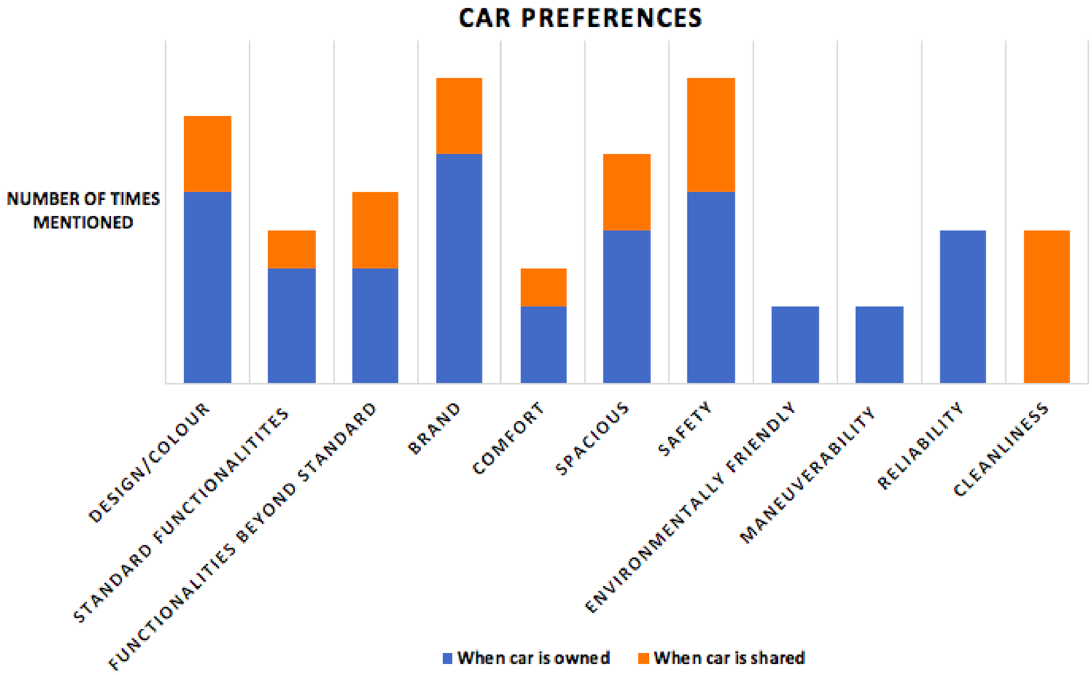
Out of the 9 interviewees, seven responded Yes to the question regarding whether they would be willing to pay extra for an autonomous car compared to a non-autonomous car. The reasoning for the people who answered Yes was quite similar; that the time they would save by not having to drive would be worth paying more for. Additionally, two of the interviewees who answered Yes stated that they thought that it would be safer to go by an autonomous car than by a non-autonomous and that they sometimes can feel uncomfortable while driving in the city due to traffic. The two that answered No did so with the reasoning that they might as well drive themselves and that they enjoy driving. Out of 9 interviewees, five persons said that they would be willing to pay extra for certain functions in the autonomous car while four answered that they would not. The persons that were willing to pay extra said it would be worth it for longer trips, while the ones who answered No stated that their commutes were short so that it would be enough to use their phones.

5.1.2 Differences in car preferences for owned and shared cars

The result from the interviews shows that the participants of the study had different requirements for an owned car compared to a shared car, see table 8. The total number of car preferences mentioned for an owned car was 39, while the same number was 23 for a shared car. Many of the requirements were mentioned both for owned and shared cars, see table 9, but each requirement is more frequently mentioned for an owned car compared to a shared one, see graph 1. Some interviewees mentioned that if they do not own the car, they do not feel as much responsibility and commitment to the car, whereby they do not care as much about some car preferences. This was the case for brand and reliability, which two interviewees stated that they would not care about in a shared context. One interviewee said that if a shared car was broken, it was probably not her responsibility to pay for the service, rather the provider of the shared car. Therefore, she did not feel that the reliability aspect was as important as if it was her own car where she needed to pay such costs.

Car preferences			
Important when owned	**Number of times mentioned**	**Important when shared**	**Number of times mentioned**
Brand	6	Cleanliness	4
Design/Colour	5	Safety	3
Safety	5	Brand	2
Reliability	4	Design/Colour	2
Spacious	4	Functionalities beyond standard	2
Functionalities beyond standard	3	Spacious	2
Standard functionalitites	3	Accessability, even for spontaneuos trips	1
Comfort	2	Comfort	1
Environmentally friendly	2	Concern for allergies	1
Manueverability	2	Customizable attributes and functionalities	1
Acquisition cost	1	Punctuality	1
Easy to keep clean	1	Rating system for ridesharing	1
Ease of use	1	Security of private data	1
Maintenance cost	1	Standard functionalitites	1
		Wouldn't care as much as when owned	1
Total mentions for category	39	**Total mentions for category**	23

Table 8. Result from interviews regarding car preferences for owned and shared cars.



Graph 1. Result from interviews regarding car preferences for owned and shared cars.

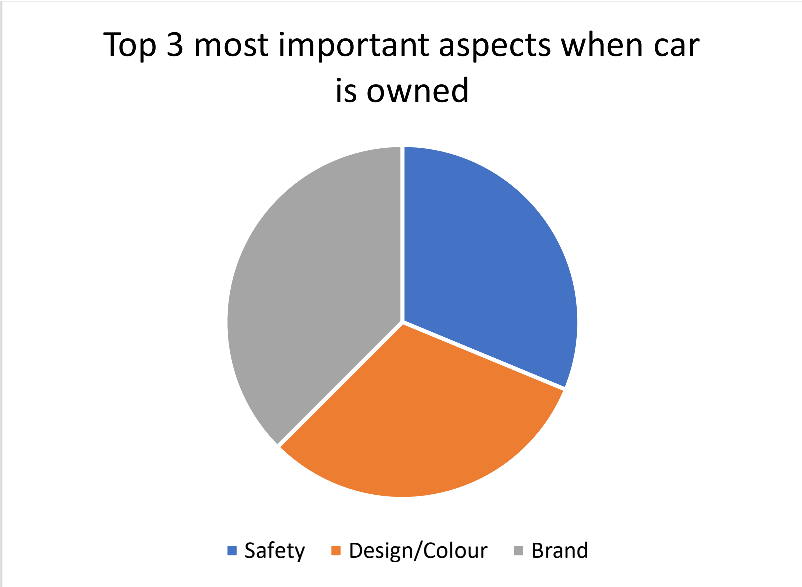
Occurs in both categories	Owned	Shared
Brand	6	2
Comfort	2	1
Design/Colour	5	2
Functionalities beyond standard	3	2
Safety	5	3
Spacious	4	2
Standard functionalitites	3	1

Table 9. Aspects mentioned for both owned and shared cars.

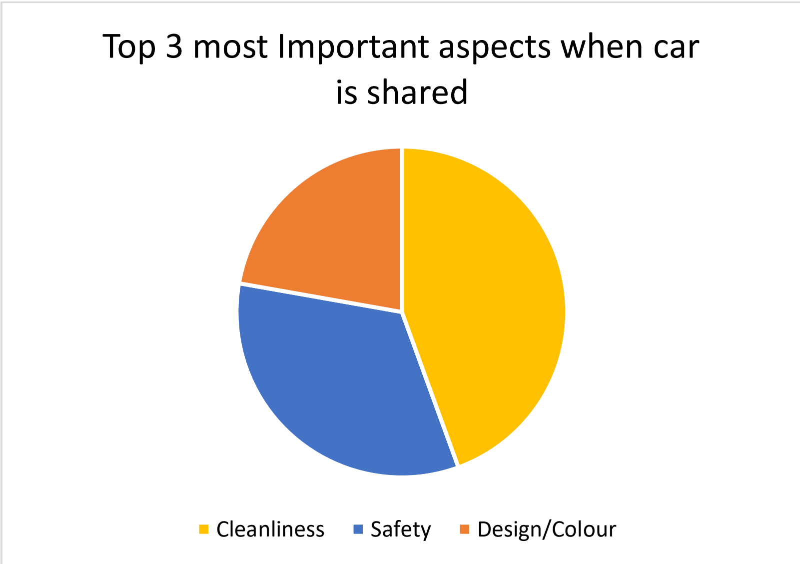
Furthermore, many of the aspects that were mentioned for a shared car were only mentioned by one person. This was the case for 13 out of 17 mentioned car preferences. Graph 2 shows the three most frequently mentioned aspects for an owned car, while graph 3 illustrates the same for a shared car. The aspects design/colour and safety are considered as being among the most important aspects for both an owned and a shared car. However, the aspect that was mentioned the most times for shared cars was cleanliness. This aspect was not mentioned at all for an owned car. There seems to be a concern that the shared car could be unclean. This was something that the interviewees felt were out of their control for a shared car since other persons would use the car as well. Two persons mentioned that since they did not know much about cars, they would definitely choose a well-known brand if they were to buy. The brand aspect was the most mentioned aspect for an owned car, while this was only mentioned by two persons for shared cars.

Overall, the aspects mentioned for a shared car were closely related to worries regarding the shared concept. In addition to the cleanliness aspect that was raised several times, other aspects such as concerns for allergies, security for personal information, punctuality and accessibility were mentioned as important aspects.

Two interviewees mentioned the environmental aspect for an owned car, but this aspect was not mentioned for the shared car.



Graph 2. Most important aspects for an owned car.



Graph 3. Most important aspects for a shared car.

6. Analysis and discussion

In the following sections, a discussion of the result will be presented together with an analysis of the future competitive landscape of autonomous cars. The analysis and discussion form the foundation for the suggested competitive key success factors that are presented in the last section.

6.1 User Experience and ownership models

In the following paragraphs, an analysis of the result from the interviews is presented and discussed. The section is divided into two parts; one relating to the activities to be performed in autonomous cars, and one regarding the preferences for owned and shared cars.

6.1.1 Activities in autonomous cars

Relaxation is the category with the greatest number of unique activities and total mentions, followed by Entertainment and Socializing. This means that these categories are the most differentiated in terms of what people would like to do. Essentially, this gives companies more opportunities to create a customized experience for their customers within these categories. Health and Learning have fewer unique activities than the three previously mentioned categories, as well as a low number of total mentions. This could depend on several factors. One might be that people to a lower degree associate Health and Learning with activities that they see fit to perform in a car, or that they just want to do activities associated with the other categories more. Working has the least amount of unique activities, with a relatively high number of total mentions. Thus, in contrast to the Relaxation, Entertainment and Socializing, Working can be interpreted as a category of activities that can be quite standardized; since most interviewees gave the same kind of answer.

Some of the most mentioned activities, regardless of category, such as “Watching tv/movies/series”, “Listening to music/podcasts” or “Playing online games”, have certain things in common. Firstly, they all require similar equipment, such as some sort of screen, internet connection, loudspeakers and apps. Secondly, although the activities seem uniform, there are currently many different providers of these services, showcased by what the interviewees state that they use in their lives today. For example, for “Watching tv/movies/series” interviewees state that they use Netflix, Cmore, HBO and Youtube. For “Playing online games”, interviewees use both computers and game consoles. Companies that could provide autonomous cars in the future can look to this fact as evidence of the opportunity to create customized user experiences. What makes this possible is the fact that the most important resources needed to perform the mentioned activities are software based. De Reuver, Sørensen and Basole (2018) state digital platforms can be customized after changing user needs. As showcased by the UX interviews, there are different demands on content and activities in autonomous cars, especially in the digital space. Thus, by providing a digital platform in their autonomous cars, automotive companies can be in an advantageous position to provide a customized, personalized user experience.

The result indicates that people might be willing to pay a premium for an autonomous car due to the value they see in being able to perform other activities than driving. Furthermore, the interviews show that some persons appreciate the self-driving technology since they imagine it being safer than driving themselves and that they are uncomfortable driving in specific areas. On the contrary, some persons express they would rather drive themselves because they enjoy it. Although there seems to be a clear majority being willing to pay extra for the technology, the number of persons expressing a willingness to pay extra for certain functionalities are not as many. Overall, this indicates that people might be willing to pay extra for the autonomous technology due to the time it relieves and due to the safety aspect, and that there might exist different customer segment when it comes to the demand for certain functionalities.

One interesting thing to note is that when drawing and describing activities in their collages, some interviewees view the autonomous cars in a shared context, even if that was never explicitly stated by the interviewer. For instance, they discuss the notions of having very specific functions in some cars, such as having a doctor and medical equipment present. These answers make little sense if they are considered in a context where the car is owned by the customer and not shared. This indicates that for some people, autonomous cars are already strongly linked to the concept of shared mobility.

6.1.2 Preferences for shared cars

There seems to be a difference between car preferences when it comes to shared cars compared to owned. Overall, the result of this study shows that people feel more responsibility and commitment to an owned car compared to a shared car. When the car is owned, the user prioritizes reliability and wants to minimize the risk of buying a car that can cause unsuspected trouble or costs. Therefore, it becomes important for the buyer to choose a brand that for the buyer is connected to reliability and safety. Other aspects that becomes more important for the user when the car is owned are design and color. One explanation to why the result shows that the user has more preferences when the car is owned compared to share can be that the interviewee finds it hard to know what he/she would value for a service that does not yet exist.

As presented in the result, people seem to have some concerns regarding a shared car service. Those concerns are linked to the fact that the car user will not have exclusive access to the car. The fact that other people will use the car creates worries regarding their behavior and how it can affect the condition of the car, especially the condition of the interior. Before the potential user can focus on aspects such as functionality and convenience, it seems like other more basic aspects need to be fulfilled. This can be an explanation for the low number of car preferences for a shared car compared to an owned car.

Although more persons seem to value aspects such as brand, design and color when the car is owned, those aspects were also mentioned for shared cars by some candidates. This indicates that there will exist different customer segments for a shared service and that a premium segment will be willing to pay extra for brand, design and image.

Furthermore, the result indicates that ownership might be linked to other responsibility aspects such as environmental responsibility. Meaning that when the car is shared among many people, the lack of commitment to the car can result in a decreased feeling of responsibility also for commonly shared aspects. Another possible explanation to why people did not mention the environmental aspect for shared cars can be that they take for granted that the car will be environmentally friendly if it is fully autonomous.

6.2 The future competitive landscape of fully autonomous cars

In these sections, a discussion of the competitive landscape of the future autonomous car industry is presented. Since there exists a belief that the autonomous technology can disrupt the car industry, it becomes important for established players to understand how the technology can come to change the competitive drivers. This can be argued as being even more important in the car industry, due to its nature of being mature; since established firms in mature markets often can miss out on investing in emerging technologies (Brown, 1992). Factors that have been presented in earlier sections will be discussed in terms of the impact they might have on the industry in the future.

Whether adoption of autonomous cars of level 4 and 5 will reach a significant level in the future is uncertain and depends according to Bansal and Kockelman (2017) on customers' willingness to pay and a progressive reduction in price for adding autonomous technology to cars. The interviews performed in this study indicate that people seem to be willing to pay more for an autonomous car compared to a non-autonomous car, due to the advantage of being able to perform a lot of activities when commuting in an autonomous car. This, in combination with the presence of Moore's Law presented by Waldrop (2016) and the technology s-curve presented by Brown (1992), makes it reasonable to assume that autonomous cars will become widely adopted after having been introduced to the market. Thus, in the following sections, autonomous cars will be viewed as having at least level 4 autonomous driving capabilities as defined by the Society of Automotive Engineers and presented by Litman (2018).

6.2.1 Factors affecting the competitive landscape

In the following paragraphs, trends and important factors that have been identified as having a high ability to affect the future competitive landscape of the autonomous car industry are presented and discussed. The factors discussed create the foundation for the future industry analysis that follows in subsequent sections.

Electric

The forecast presented by Nykvist and Nilsson (2015) that electric vehicles will become cheaper to produce, in combination with the trend towards more environmentally friendly mobility choices, indicates that the future autonomous car could be electric. Thus, in the future scenario discussed in the coming sections, the cars will be assumed to be electric.

Shared

The estimations of Grosse-Ophoff, Hausler, Heineke and Möller (2017) shows that the market for shared mobility in 2016 reached approximately $54 billion with a projected growth of 15% to 28% per year until 2030. This can be seen as an indication that shared mobility will become more prevalent in the future. Additionally, as presented in the subsections of section 3.2, several CEOs of companies investing in autonomous vehicle technology have also stated that they will introduce shared mobility services in the future. Furthermore, as the study of Gruel and Stanford (2016) shows, congestion can worsen if autonomous cars are introduced without being shared. Thus, it is reasonable to assume that there will be efforts made, possibly by legislators, to encourage autonomous car companies towards offering shared mobility.

Due to the abovementioned factors, it is assumed that in a possible future scenario of level 4 autonomous cars, the cars will be shared. If cars will be shared among citizens, the number of cars per capita can decrease. As Machado, De Salles Hue, Berssaneti, Quintanilha (2018) state, private vehicles are in use on average only 5% of the time, meaning that a system of shared vehicles could result in a decreased number of cars needed to satisfy mobility demand. Shared, autonomous cars might be able to operate much closer to 100% of the time, with the only downtime resulting from charging and service of the vehicles.

New business models lead to new competitors

Since the autonomous cars are assumed to go from owned to shared in the future, the offering to the customer will be a service rather than a product. Companies will be able to offer the service of mobility, in line with what Uber and Lyft do today. Thus, it is reasonable to assume that industry boundaries will move from what the automotive industry is today, to include all types of firms offering mobility services with autonomous cars as the transportation mode. Essentially, the traditional automotive makers might adopt a new type of service-based business model, while companies currently providing ride-hailing services might incorporate autonomous vehicle technology in their businesses. Companies that today are not seen as competitors in the traditional automotive industry, could in the future be direct competitors, which would impact on the forces of competition within the industry.

New suppliers

Due to the different ways companies are developing autonomous vehicle technology, there might be new types of suppliers in the industry. As ride-hailing service companies such as Uber and Waymo move towards building their own fleets of vehicles, these need to be sourced from other companies. This is already happening as shown in the subsections of section 3.2.4, as Uber is currently sourcing its vehicles from Volvo Cars, Waymo from Jaguar and Lyft from BMW. However, while Volvo is supplying cars to Uber, they are also developing their own autonomous car technology. This might become a conflict of interest in the future if Volvo were to create its own shared mobility service based on its autonomous cars, as Volvo would be supplying cars to a direct competitor. Thus, a new type of supplier can emerge in the industry, with the only purpose of supplying cars to ride-hailing companies.

6.2.2 Industry analysis - the future industry of autonomous cars

In the following sections, an industry analysis of the future autonomous car industry will be presented. The analysis follows the structure of the Porter’s five forces framework. The arguments are based on the trends and factors presented in section 6.2.1, along with the discussions in section 6.1.

Threat of new entry

Depending on the position a firm wishes to take within the future shared car industry, the barriers to enter the industry can either come to increase or decrease.

According to Gruel and Stanford (2016), the combination of autonomous cars and shared mobility services would result in fewer cars in circulation in total. This would probably reduce the total quantities of vehicles produced. Since there is an overcapacity in the industry today (Grant, 2016), and a lower demand regarding the number of cars is expected, large established car manufacturers might face even more overcapacity. If the cars are shared, this overcapacity can be used in order to serve a larger market to a lower price than smaller competitors. This would mean that the largest car manufacturers might gain more market share whereby this part of the industry becomes more consolidated. This indicates that some traditional dimensions of competition, such as economies of scale, still would be important.

Capital requirements have traditionally been high mainly due to cost for production and distribution channels. Compared to today's car industry, the cost of production can come to increase when cars become more complex due to the autonomous vehicle technology. If the ownership of cars shifts to a shared model such as a subscription service, the currently important entry barriers in terms of distribution channels can change. Since the customer can sign up to a subscription service with the use of an app or an internet service, the competitive advantage of having a large distribution network in terms of retailers and wholesalers can run obsolete. However, a well-established distribution network can still be advantageous in terms of distributing cars from manufacturing to the place where they are intended to operate. The factors mentioned above can contribute to that the barriers to enter the industry as a car manufacturer might increase.

In the future industry of shared autonomous cars, there might be a possibility for new entrants to circumvent entry barriers that are in place in the current car industry, such as the high capital requirements for manufacturing cars. This is due to the fact that it could be possible for new entrants to invest in a fleet of fully autonomous cars and the software necessary to introduce a ride-hailing service. However, as ownership models change towards shared mobility, there will be a new entry barrier as companies need to have a certain number of cars in circulation in order to reach a satisfying level of accessibility for the customer. This creates large capital requirements in investment costs and means that firms need to reach a critical mass of users in order to be profitable. An established firm with a large installed base of users will therefore have a competitive advantage. The term "installed base" in this context refers to a firm's number of cars or users that will be reached by the new technology and business model.

Brand identification has traditionally been a strong entry barrier in the automotive industry. This brand loyalty can be important in the early stage of the introduction of shared autonomous cars since it can help firms to attract the early adopters and faster reach a critical mass of users. According to Pettersson's and Karlsson's research (2015), the safety aspect of autonomous cars is a concern for many people, which also have been found in this study. Therefore, established automakers that have a reputation of being safe can have an advantage in terms of being able to take a large market share in the early stage.

The bargaining power of suppliers

Since it is assumed that the autonomous cars will be electric, the suppliers of batteries will be of high importance for future electric car manufacturers. The battery will constitute an important part of the car and it is likely that car manufacturers will enter into close relationships with battery manufacturers, in line with the information presented by Nienaber, Taylor, Schwartz, Vaish and Felix (2018). The supplier power of battery providers is therefore likely to be relatively high. Mobility service providers that do not produce their own cars but have their own autonomous vehicle technology will have suppliers of cars. Those firms are likely to engage in close collaboration with vehicle providers in order to build a mutual dependency.

In order to meet the demand from the users regarding activities they want to be able to perform in the car, many companies in the future shared autonomous car industry could come to provide some sort of solution that enables users of autonomous cars to consume digital content. The results of the interviews show that people want to have access to digital apps that they currently can access at home and on their phones. There are several ways for automakers to offer this to their users in the future. Either, they can provide an interface for users to connect their phones to the autonomous car, or they can provide a platform for content specifically made for autonomous cars. Companies can create such platforms internally, or they can seek collaborations with companies that could provide a platform for them. Regardless of how the platform is supplied, there will be a need for third-party developers to create content for the platform. If a company were to utilize a platform created by another firm, this platform supplier will become very important since the platform will play an important part in the offering to the user. If companies want to avoid the risk of becoming too dependent on a platform provider, they might consider developing their own platform.

The bargaining power of buyers

The end customer of the autonomous shared mobility service will be individuals, meaning that the relative bargaining power of buyers will still be low. Nonetheless, as car companies are likely to adopt new business models and start to offer mobility services instead of selling cars, the switching costs for buyers are likely to change. If the companies that might offer mobility services in the future adopt a business model similar to that of Uber, which does not bind customers in subscriptions, the switching costs for customers will become very low. Contrastingly, if companies make customers subscribe to their mobility services and bind them for longer periods of time, switching costs would be higher. No matter which of the mentioned alternatives, the switching costs will probably decrease when moving towards shared autonomous mobility. Transparency regarding offerings will also be high, which makes it easy for customers to compare services and lowers the switching costs further.

Companies can utilize the fact that customers will be freed up from the responsibility of driving, enabling them to do other activities while traveling by car. By adopting a platform business model for offering content and activities in their cars digitally, the companies can create positive two-sided network effects, in line with the reasoning of Eisenmann, Parker and Van Alstyne (2006). Furthermore, if the customer gets used to a specific platform, this can create lock-in effects making it harder for the customer to switch to another solution, increasing switching costs further.

There will be more space for companies to differentiate themselves based on what they offer their customers, as the removed need for a driver also removes limits on the design of the car. Essentially, this creates opportunities for companies to redesign what a car is and how it looks and functions. The more differentiated the cars become, the harder will it be for the customer to find a similar offering for the same price and the higher will the switching cost be for the user.

Whether the bargaining power of customers will increase or decrease compared to that of the current market will highly depend on the type of subscription models offered as well as the nature of competition in terms of differentiation between companies in the future. A future market with companies offering differentiated mobility solutions with binding subscription models will result in high switching costs. If companies offer undifferentiated solutions without subscriptions, customers will face low switching costs.

The threat of substitutes

The shared, autonomous, electric car can become a threat to some of today's transportation modes due to its potential to become a more comfortable, flexible and environmentally friendly transportation mode than today's cars. Cost, travel time, flexibility and comfort are the most important factors when people chose the mode of transportation (Garvill, 1999). The autonomous technology in combination with the shared mobility can improve these factors so that the car can compete with other transportation modes to a larger extent. Autonomous cars can enable people to engage in more activities that they are unable to do while driving a car today. This could make the car even more attractive in comparison to other transportation modes, lessening the threat of some substitutes even further. Furthermore, when the car is shared, and a subscription model is used instead of ownership, the total cost for using the car can be expected to decrease. The comfort of traveling could increase while the user has more space and the ability to perform other tasks in the car than driving. This could mean that the customer might be willing to replace train and airplanes with the car for some travels, especially domestic. Furthermore, a shared mobility platform for autonomous cars could result in positive network effects, meaning that the value for the user will increase with the number of users since more cars will be in circulation, affecting the availability and flexibility positively. Concluding, the already low threat of substitutes can be expected to decrease even more in the future.

Industry rivalry

If the boundaries of the market expand to include new types of players, the number of competitors is likely to increase, leading to a higher industry rivalry between the firms. If the cars are shared, a prerequisite for firms to become successful in their offering will be to reach a critical mass of users and cars in circulation. This could lead to a scenario where the market becomes consolidated and dominated by a few actors. This could lead to competition between established firms being more about product differentiation rather than price competition.

The interviews performed in this study show that the activities that people want to perform in the autonomous car differ. It can be difficult for firms to offer all the equipment needed to satisfy every customer. Furthermore, the result also shows that the car preferences for shared cars vary where some people might value premium cars with a particular image while other people just want to ride as cheap as possible in a safe way. This opens for the argument that there will exist different customer segments and that smaller firms can niche towards specific users. This then contradicts the reasoning that the market will be dominated by just a few shared mobility firms. Firms can niche either by building upon a differentiation strategy or a cost leadership strategy, in line with Porter's (Porter, 1979) competition strategies. Such differentiation strategy could for example be to offer a premium experience for entertainment in the car, through a digital content platform and an interior with great comfort and soundproofing and dim-out systems. A cost leadership strategy when it comes to UX could be to simply let the user of the autonomous car bring their own laptop or other equipment and only provide an internet connection.

Whether the industry rivalry will increase or decrease compared to that of today's market will depend on the ability of a single firm to meet different customers segments when it comes to what people want to do in the car. This could have a strong effect on whether the market becomes consolidated or fragmented and the ability for smaller niche players to gain market share. If a platform business model with content supplied by third-party providers is applied, the ability of a firm to provide a broad offering becomes higher than if the company would try to provide content by itself. If large firms would apply this strategy successfully, they would be able to serve many customer segments and the probability of the market being dominated by a few actors increases.

6.2.3 Current market players and their relative competitive advantages

As presented in section 3.2, the future market of autonomous shared cars will have players with different backgrounds regarding whether they produce their own cars or not. The firms that do not produce their own cars; such as Waymo, Uber and Lyft, also differ in regard to their background and experience. When entering the industry of autonomous and shared cars, Lyft and Uber already had established ride-hailing services that connect passengers with drivers. Waymo is currently building its service with a starting point in the company's autonomous vehicle technology. Furthermore, the car manufacturers brought up in this study differ in that Ford is one of the oldest car companies in the world, while Tesla is a relatively new company. Whether Apple will take a position as a car manufacturer or not is a bit unclear judging by the reporting of the company's autonomous car project. Depending on the different backgrounds of the companies, they might enter the industry of autonomous cars with different competitive advantages, which will be discussed in the sections below. Noteworthy is that all the aforementioned companies are likely to adopt a shared mobility service as their offering, whereby the customer might not notice this difference in the firm's business models.

Firms that today are well-established car manufacturers can have some competitive advantages compared to non-manufacturers when moving into the future industry of autonomous shared cars. The results of the interviews of this study show that people are concerned regarding the safety aspect of riding in a shared autonomous car. This means that firms that have an established brand and a reputation of providing safe cars can have an advantage in the early stage of the introduction of autonomous shared cars. Additionally, this can potentially help firms to reach a critical mass of users at a faster pace. However, many of the firms that do not manufacture their own cars will use cars from large car manufacturers such as Volvo, BMW and Jaguar, which have reputations of being safe. Thus, this potential competitive advantage might be diminished for established car manufacturers in comparison to ride-hailing companies. Traditionally, the car manufacturing industry has been characterized by large economies of scale, which has resulted in high entry barriers. Although the number of cars manufactured per firm can come to decrease, car manufacturers will have a cost advantage compared to the firms that need to source cars from car manufacturers. Furthermore, firms that buy their cars from car manufacturers will have less control over their fleet than car manufacturers and can to some extent become dependent on the car supplier. The level of dependency will in high extent depend on the relative bargaining power that the firm possesses. For a large firm such as Uber, this can be expected to be relatively high. For such firms, it might not be beneficial to vertically integrate to start manufacturing their own cars since they still possess a good position and would lose a lot of flexibility.

Established car manufacturers might not just derive advantages from their background when moving into the new industry structure of autonomous and shared cars. The transformation from selling cars as a product to providing a mobility service can be challenging for established firms that have a long background in the traditional car industry. These firms might come to face a rigidity in this change that newer companies might not. A good illustration of this can be to compare Ford and Tesla. Tesla has entered the car industry with an idea that the future car will be autonomous, shared and electric and has therefore equipped all their cars with hardware and software necessary for fully autonomous driving. Furthermore, they have developed their own batteries and prepares for a shared service with the Tesla Network. In contrast, Ford has been in the car industry since 1903 and during their lifetime as a leading car manufacturer, the car industry has not undergone the amount of change that it could face in the coming decades due to the opportunities that autonomous vehicle technology generates. Since Ford is a large, well-established company in an old industry, its culture and company structure can make the shift difficult.

Furthermore, the customers of car manufacturers might react differently to the introduction of shared autonomous cars than customers of ride-hailing services. Essentially, the advantages of the installed base can differ between car manufacturers and ride-hailing service providers possess. For instance, it will probably be easier for a customer of Uber to accept a shared autonomous mobility service than for a customer of Ford. Tesla, in turn, has a quite large "installed base" in terms of sold cars in circulation. With the hardware necessary for fully autonomous driving and the ability to download the necessary software over-night in combination with the Tesla Network, they have a favorable position in taking a large portion of the shared mobility market compared to other companies.

Providing great content and activities for users of autonomous cars might be difficult to do for automotive companies as this might lie outside of their capabilities and resources. Hence, taking a platform approach could help automotive companies by connecting users of autonomous cars with third-party providers of apps for their needs regarding activities to perform, in line with arguments put forth by De Reuver, Sørensen and Basole (2018). Furthermore, in accordance with the reasoning of Eisenmann, Parker and Van Alstyne (2006), when the experience of the car will be about what activities users are able to perform when riding in an autonomous car, connecting them with third-party providers will strengthen the offer of the autonomous car manufacturer by increasing the value perceived by the users.

Looking at the companies currently attempting to develop fully autonomous cars, it is evident that they are in different positions regarding their abilities and possibilities to introduce a digital platform in their autonomous cars in the future. For instance, both Apple and Google are currently developing autonomous car technology, and both have their own smartphone platform. Bringing their platforms to their vehicles in order to give their users access to apps when riding in their autonomous cars will probably not be an issue for either company. Ford and Tesla, however, do not have a current app platform. Thus, if they would wish to include this in their autonomous cars in the future, they would have two options; develop their own platform or reach an agreement with a platform provider. The first option entails not just creating the digital space where content can be accessed by the user, but also to bring in third-party providers that can provide exclusive content for the platform. This option can give the autonomous car manufacturer more control but can be costly. The second option would mean sourcing the platform from a company such as Apple or Google, which has a platform structure ready for use. Such a strategy would probably be simpler and more effortless but could at the same time result in less control and a higher degree of dependency on the platform provider. Uber and Lyft are a bit different in this case, as they both are software companies whose businesses are based on a platform model, meaning that they probably would be in a better position than Ford and Tesla in creating a platform. Their current platforms are however focused on connecting drivers with riders, meaning that they still would have to put in the effort to attract third-party providers for content to their platform.

6.3 Key success factors

As shown in figure 4, Grant (2016) identifies key success factors as originating from the competitive aspects of an industry in combination with the demands of customers.

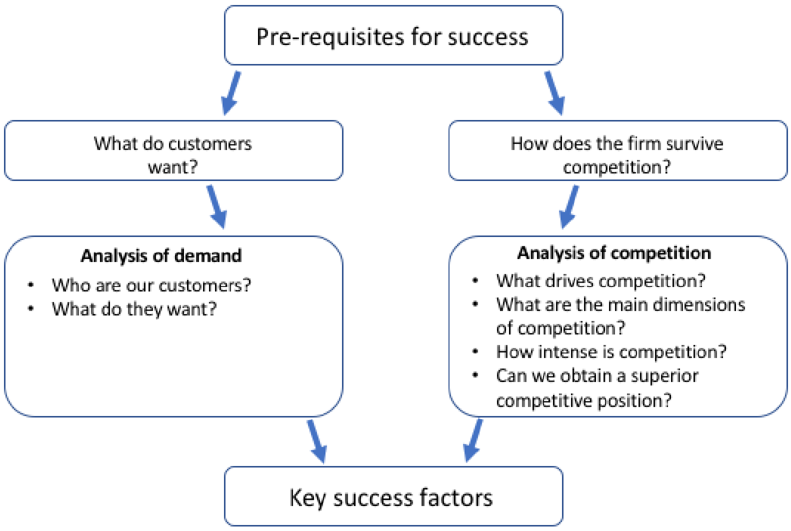


Figure 4. The process of identifying Key Success Factors (Grant, 2016).

This study indicates that the shift towards autonomous and shared cars can change the customers' preferences regarding what they expect from the car. This change relates both to car preferences such as brand, image, design and reliability but also to the activities that customers want to perform in the car. There will be a need for new kinds of hardware and software not present in current cars, in order to facilitate the multitude of activities raised by the interviewees of the study. Additionally, regarding the shared aspect of the autonomous car, there seems to exist a concern regarding factors that lie outside of customers control. Companies need to address these factors in order to deliver an offer that will be deemed trustworthy by customers.

Furthermore, this study has highlighted indications that the introduction of shared autonomous cars can come to change the competitive landscape of the car industry. The boundaries of the industry will shift to include more types of players that come from different backgrounds and with different prerequisites to obtain a competitive advantage. The industry can come to face strong industry rivalry between firms, which will put higher pressure on companies to differentiate. Furthermore, it will become crucial for firms to have enough cars in circulation in order to offer the customer a satisfying level of accessibility.

In table 10, the analyses of demand and competition are summarized, along with the key success factors that have been derived from those analyses. Among the key success factors are aspects that are recognized as important in the current car industry; such as economies of scale and differentiation regarding quality, image and design. However, new aspects have been identified as playing an important role in firms' ability to build a competitive advantage in the shared autonomous car industry. One such aspect, that has been mentioned as a new entry barrier for the industry, is firms' need to supply a critical mass of cars to the customers. Furthermore, positive network effects among the users in the system can be achieved. Firms can have an advantage in having a large installed base when entering the market as it can help them reach a critical mass of cars in circulation. This installed base can be either in terms of users of a ride-hailing service, as for Uber, or in terms of cars present at the market with autonomous and shared technology, as for Tesla. Moreover, companies might be able to compete successfully by providing a customized solution regarding activities to be performed while riding in their autonomous cars. This could be achieved by providing a digital platform in the cars, enabling customers to access content provided by third-party developers. By attracting third-party providers and leveraging a large installed base, two-sided network effects could be achieved, further strengthening the offering to the customers.

What do customers want? (analysis of demand)	How do firms survive competition (analysis of competition)	Key Success Factors
•Diversity of car preferences •Flexibility and accessibility •Safety •Cleanliness •Willingness/ability to pay premium for certain functionalities •Diversity of activities in the car	•Price competition •Strong industry rivalry •High entry barriers for car manufacturers •Enough cars in circulation	•Critical mass of cars •Installed base •Network effects •Economies of scale •Differentiation regarding activities in the cars, quality and image •Customized solution regarding activities

Table 10. Identified Key success factors for the autonomous car industry.

7. Conclusions

At the beginning of this thesis, four research questions were raised:

1. *What activities will people want to perform in future fully autonomous cars?*
2. *Do people have different car preferences for a shared car compared to an owned car?*
3. *How can autonomous cars change the competitive landscape of the car industry?*
4. *What can be competitive key success factors in the future autonomous car industry?*

A combination of a review of previous literature and empirical studies have formed the foundation for answering these questions. The conclusions regarding each research question are presented in this section, along with some final recommendations.

What activities will people want to perform in future fully autonomous cars?

In order to answer this question, the participants in the interviews were asked to draw collages of activities they would want to perform in an autonomous car within six categories; Relaxation, Entertainment, Socializing, Health, Learning and Working. Then they were asked to describe what they had drawn and written on the collages.

Based on these observations, it seems like the interviewees are most likely to want to relax, be entertained or socialize while riding in an autonomous car. Within these categories, the most mentioned activities are to "watch tv/series/movie" and "listen to music/podcast/audiobooks". This indicates that the activities to be performed in a future autonomous car will not differ to a great extent between users and that the same hardware could be used in order to satisfy a large number of customers. However, the interviews showed that people consume content within these activities through different digital channels.

Do people have different car preferences for a shared car compared to an owned car?

In order to answer this question, the persons participating in the interviews were first asked to mention what aspects they value if they were to buy a car today. Then they were asked the same while imagining that they would be subscribers to a shared mobility service.

People seem to value the car differently if it is shared compared to if it is owned. Perhaps the most telling of the result is the fact that the interviewees gave fewer points of value for a shared car. It seems that the interviewees feel more responsibility for and commitment to an owned car compared to a shared one. When buying a car, reliability and brand are highly valued. This indicates that the interviewees value cars that would not cause unsuspected costs and concerns when owned. In a shared context, reliability is not even mentioned. Instead, cleanliness is the most mentioned point of value, showing that the fact that other people would be riding in the same car is a concern for the interviewees. Worries regarding the condition of the interior of the shared car would have to be taken care of before people can start focusing on other aspects such as the functionalities.

However, the interviews gave indications that aspects connected to image and brand still can be important for some customers. To conclude, this points at the fact that there will exist different customer segments for the shared autonomous car, just as for today's owned cars, but also that the feeling of not being as responsible for the shared car might lower the requirements for some people.

How can autonomous cars change the competitive landscape of the car industry?

This study indicates that the competitive landscape of the car industry can come to undergo several changes when autonomous cars are adopted. New types of players that have not been part of the traditional car industry, might change the industry boundaries and challenge current market players. The car manufacturers of today could come to compete with companies that are currently providing ride-hailing services, as both types of companies are developing autonomous cars and expressing intentions of introducing a new type of shared mobility service. Since many of today's ride-hailing service providers source cars from firms that in the future can be their direct competitors, complex relationships between firms can emerge.

The drivers of competition will most probably increase in number and can have many implications for the competition in the industry. In this study, it has become important to separate car manufacturers and ride-hailing service providers when discussing how the competitive landscape will change and what implications it will have on firms. The traditional important drivers of competition, such as economies of scale and a well-established distribution network, will still be of importance for car manufacturers. Due to the expected lower number of cars being produced, car manufacturers can become more consolidated. While traditional drivers for competition still will be present, the introduction of shared mobility services based on fleets of autonomous cars can create competitive factors that are new for the car industry; such as having a critical mass of users and creating network effects and lock-in effects.

What can be competitive key success factors in the future autonomous car industry?

The key success factors of the future autonomous car industry have been identified in this study as being highly influenced by the expected shift from an ownership model to a shared mobility service. As mentioned in the previous section, car manufacturers will probably still compete on traditional drivers of competition, whereby economies of scale have been identified as one key success factor for the future autonomous car industry. However, this study has also identified key success factors that will be of importance for firms providing a shared mobility service; a critical mass of cars, an installed base of users and network effects become important competitive advantages.

The car industry has traditionally been characterized by differentiation in regard to brand, image, quality and price levels. This study indicates that the ability to differentiate will still be a key success factor for firms. However, the parameters of differentiation can come to change when cars become autonomous and shared. The autonomous technology creates new opportunities for firms to differentiate in regard to the activities the users perform in the car. This study indicates that people want to perform several types of activities in the car, mostly related to digital solutions. The use of a digital platform in the car has been proposed and discussed as a way of providing a customized offering of activities to passengers of future autonomous cars. Such a platform could create two-sided network effects between third-party developers and users and would enable firms to offer their customers a customized user experience.

Recommendations

This study has concluded that the competition within the car industry can come to increase in the future, both for car manufacturers and shared mobility providers. A shift to shared mobility indicates that the total market of produced cars decreases, whereby the advantages of reaching economies of scales might consolidate the market and make it hard for smaller firms to compete. Therefore, the recommendation given to car manufacturers is to focus on building close relationships with shared mobility providers, in order to secure demand. Furthermore, car manufacturers are recommended to equip all their cars with the necessary equipment for autonomous driving and shared mobility, in order to make the most out of the installed base of users in the transition to a shared autonomous mobility service.

This study has also discussed key success factors for firms that enter the market with a shared mobility service. Such firms are recommended to focus on a short time to market in order to reach a critical mass of users. To focus on building network effects as well as lock-in effects will also strengthen the competitive advantage for those firms.

Further research

As this study has only begun to qualitatively explore how people will want to spend their time in autonomous cars, it would be interesting to perform further research on a larger scale. By including more people, a higher degree of reliability, relevance and usefulness to the industry could be achieved. Additionally, to include persons from a wider demographical range will give more well-defined insights and the possibility to identify different customer segments. Furthermore, the findings of this study are based on the interviewees' current lives, interests and perceptions, which might come to change as time passes. Thus, as it probably will take at least one or two decades before shared autonomous cars become widely adopted, it is necessary to point out the need for continuous research in this field.

9. References

Anderson, J. M., Nidhi, K., & Stanley, K. D. (2014). *Autonomous vehicle technology: a guide for policymakers*. Retrieved from https://ebookcentral.proquest.com

Bansal, P., & Kockelman, K. M. (2017). Forecasting Americans' long-term adoption of connected and autonomous vehicle technologies. *Transportation Research Part A: Policy and Practice, 95,* 49-63.

Bower, J. L., & Christensen, C. M. (1995). Disruptive technologies: catching the wave.

Brown, R. (1992). Managing the "S" curves of innovation. Journal of Business & Industrial Marketing, 7(3), 41-52.

Bryman, A. and Bell, E. (2014). *Research Methodology: business and management contexts.* Cape Town: Oxford University Press South Africa.

Chen, J. (2018). Switching costs and network compatibility. *International Journal of Industrial Organization, 58.* 1-30.

Clewlow, R. R., & Mishra, G. S. (2017). Disruptive transportation: The adoption, utilization, and impacts of ride-hailing in the United States. *University of California, Davis, Institute of Transportation Studies, Davis, CA, Research Report UCD-ITS-RR-17-07.*

Davis, A. (2018, December 13). *The Wired Guide to Self-Driving Cars.* Retrieved from: https://www.wired.com/story/guide-self-driving-cars/

de Reuver, M., Sørensen, C., & Basole, R. C. (2018). The digital platform: a research agenda. *Journal of Information Technology, 33*(2), 124-135.

Dobbs, M. E. (2014). Guidelines for applying Porter's five forces framework: a set of industry analysis templates. *Competitiveness Review, 24(*1), 32-45.

Dobush, G. (2018, October 31). *A Tesla Model S on Autopilot Rammed a Parked Car at 80 mph. Now the Driver is Suing.* Retrieved from: http://fortune.com/2018/10/31/tesla-model-s-autopilot-crash-lawsuit/

Dockalikova, I., & Klozikova, J. (2014, November). MCDM Methods in Practice: Determining the Significance of PESTEL Analysis Criteria. *In European Conference on Management, Leadership & Governance* (p. 418). Academic Conferences International Limited.

Easterby-Smith, M., Thorpe, R., & Jackson, P. R. (2015). *Management and business research*. Sage.

Ellis, B., Douglas, N., & Frost, T. (2016, November). Willingness to pay for driverless cars. In *Australasian Transport Research Forum (ATRF), 38th, 2016, Melbourne, Victoria, Australia.*

Eisenmann, T., Parker, G., & Van Alstyne, M. W. (2006). Strategies for two-sided markets. *Harvard business review, 84(*10), 92.

Encyclopædia Britannica, inc. (2019). *Ford Motor Company.* Retrieved from: https://www.britannica.com/topic/Ford-Motor-Company

Favarò, F., Eurich, S., & Nader, N. (2018). Autonomous vehicles' disengagements: trends, triggers, and regulatory limitations. *Accident Analysis & Prevention, 110,* 136-148.

Feng, G., Kong, G., & Wang, Z. (2017). We are on the way: Analysis of on-demand ride-hailing systems. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2960991

Ford Motor Company. (2019). *Looking Further: Ford Will Have a Fully Autonomous Vehicle in Operation by 2021.* Retrieved from: https://corporate.ford.com/articles/propulsion-choices/autonomous-2021.html

Garvill, J. (1999). Foddy, M., Hogg, M. A., Smithson, M., & Schneider, S. (Eds.). *Resolving social dilemmas: Dynamic, Structural, and Intergroup Aspects.* Retrieved from https://books.google.se/books?hl=en&lr=&id=rLtAs7YxSTgC&oi=fnd&pg=PA263&dq=choice+of+transportation+mode&ots=CRWbCaB-t6&sig=u0-3n9x-dB_JaJvm1-cjfrkyj4E&redir_esc=y#v=onepage&q&f=false

Grant, R. M. (2016). *Contemporary strategy analysis: Text and cases edition.* Hoboken, New Jersey: John Wiley & Sons.

Grosse-Ophoff, A., Hausler, S., Heineke, K., & Möller, T. (2017). How shared mobility will change the automotive industry. *McKinsey & Company.* Retrieved from: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/how-shared-mobility-will-change-the-automotive-industry

Gruel, W., & Stanford, J. M. (2016). Assessing the long-term effects of autonomous vehicles: a speculative approach. *Transportation research procedia, 13*, 18-29.

Hanley, S. (2019, February 20). *Elon Musk: Full Self-Driving Teslas This Year, "Unequivocal" Tesla Autopilot Improves Safety.* Retrieved from: https://cleantechnica.com/2019/02/20/elon-musk-full-self-driving-teslas-this-year-unequivocal-tesla-autopilot-improves-safety/

Hassenzahl, M., & Tractinsky, N. (2006). User experience-a research agenda. *Behaviour & information technology, 25*(2), 91-97.

Hatch, J., & Helveston, J. (2018). *Will Autonomous Vehicles be Electric?.* Retrieved from: https://www.bu.edu/ise/2018/08/27/will-autonomous-vehicles-be-electric/

Holweg, M. (2008). Parry, G., & Graves, A. P. (Eds.). *Build to order: The road to the 5-day car.* Berlin/Heidelberg: Springer Science & Business Media.

Holland, F. (2018, November 15). *Here's how Ford's autonomous vehicles will shake up ride hailing and delivery services.* Retrieved from: https://www.cnbc.com/2018/11/15/ford-plans-a-ride-sharing-service-with-its-self-driving-cars-by-2021.html

Ilková, V. ; Ilka, A. (2017) "Legal Aspects of Autonomous Vehicles – an Overview". Proceedings of the 2017 21st International Conference on Process Control (PC), Štrbské Pleso, Slovakia, June 6 – 9, pp. 428-433

Innovate UK & Centre for Connected and Autonomous Vehicles. (2018). *£25 million boost for self-driving technology: apply for funding.* Retrieved from https://www.gov.uk/government/news/25-million-boost-for-self-driving-technology-apply-for-funding

Katz, M. L., & Shapiro, C. (1985). Network externalities, competition, and compatibility. American economic review, 75(3), 424-440.

Kolodny, L., Farr, C., & Eisenstein, P. A. (2019, January 24). *Apple just dismissed more than 200 employees from Project Titan, its autonomous vehicle group.* Retrieved from: https://www.cnbc.com/2019/01/24/apple-lays-off-over-200-from-project-titan-autonomous-vehicle-group.html

Kurzweil, R. (2004). The law of accelerating returns. In Alan Turing: Life and legacy of a great thinker (pp. 381-416). Springer, Berlin, Heidelberg.

Lambert, F. (2017, May 1). *Tesla Network: Elon Musk elaborates on autonomous ride-sharing, says will eventually be cheaper than public transport.* Retrieved from: https://electrek.co/2017/05/01/tesla-network-elon-musk-autonomous-ride-sharing-vision/

Lane, B. W., Messer–Betts, N., Hartmann, D., Carley, S., Krause, R. M., & Graham, J. D. (2013). Government promotion of the electric car: Risk management or industrial policy?. *European Journal of Risk Regulation, 4*(2), 227-245.

Litman, T. (2018). *Autonomous vehicle implementation predictions.* Victoria, Canada: Victoria Transport Policy Institute.

Lu, N., Cheng, N., Zhang, N., Shen, X., & Mark, J. W. (2014). Connected vehicles: Solutions and challenges. *IEEE internet of things journal, 1*(4), 289-299.

Lyft. (2019a). *A ride whenever you need one.* Retrieved from https://www.lyft.com/signup

Lyft. (2019b). *Revolutionizing cars, reshaping the future.* Retrieved from https://www.lyft.com/self-driving-vehicles/engineers

Machado, C., de Salles Hue, N., Berssaneti, F., & Quintanilha, J. (2018). An Overview of Shared Mobility. *Sustainability*, *10*(12), 4342. MDPI AG. Retrieved from http://dx.doi.org/10.3390/su10124342

Matousek, M. (2018, May 3). *Elon Musk Said Tesla's Uber-like car service will probably arrive by the end of 2019.* Retrieved from: https://www.businessinsider.com/elon-musk-tesla-network-ready-in-2019-2018-5?r=US&IR=T&IR=T

Maurer, M., Gerdes, J. C., Lenz, B., & Winner, H. (2016). *Autonomous driving.* Springer Berlin Heidelberg, Berlin, Germany.

Meyhofer, E. (2018, December 31). *Annual Report of Autonomous Vehicle Disengagements.* Retrieved from: https://www.dmv.ca.gov/portal/wcm/connect/f19a3a59-0e7f-4827-9318-9a9684aa0864/UATCLLC_UBER.pdf?MOD=AJPERES&CVID=

MBAF. (2018). *How will Trump Tariffs Impact the Auto Industry.* Retrieved from: https://mbafcpa.com/advisories/how-will-trump-tariffs-impact-auto-industry/

Nellis, S., & Sage, A. (2019, February 13). Apple ramps up self-driving program as Waymo says its tech improves. *Reuters.* Retrieved from: https://www.reuters.com/article/us-apple-autos-autonomous/apple-ramps-up-self-driving-program-as-waymo-says-its-tech-improves-idUSKCN1Q22F6

NHTSA. (2019). *Automated Vehicles for Safety.* Retrieved from https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety

Nienaber, M., Taylor, E., Schwartz, J. C., Vaish, E., & Felix, B. (2018, November 9). Clarke, D. (Ed.) Factbox: Plans for electric vehicle battery production in Europe. *Reuters.* Retrieved from: https://www.reuters.com/article/us-autos-batteries-europe-factbox/factbox-plans-for-electric-vehicle-battery-production-in-europe-idUSKCN1NE0K5

Nykvist, B., & Nilsson, M. (2015). Rapidly falling costs of battery packs for electric vehicles. *Nature climate change, 5*(4), 329.

O'Flaherty, D. (2018). *AI in action: Autonomous vehicles.* Retrieved from: https://www.ibm.com/blogs/systems/ai-in-action-autonomous-vehicles/

Pettersson, I. (2017). Travelling from fascination to new meanings: Understanding user expectations through a case study of autonomous cars. *International Journal of Design, 11*(2), 1.

Pettersson, I., & Ju, W. (2017, June). Design techniques for exploring automotive interaction in the drive towards automation. In *Proceedings of the 2017 Conference on Designing Interactive Systems* (pp. 147-160). ACM.

Pettersson, I., & Karlsson, I. C. M. (2015). Setting the stage for autonomous cars: A pilot study of future autonomous driving experiences. *IET Intelligent Transport Systems, 9*(7), 694-701. doi:10.1049/iet-its.2014.0168

Porter, M. E. (1979). How competitive forces shape strategy. *Harvard Business Review, 57*(2), 137. Retrieved from http://proxy.lib.chalmers.se/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=edb&AN=3867673&lang=sv&site=eds-live&scope=sit

Prescott, A. (2018, December 31). *Re: Autonomous Mode Disengagements for Reporting Year 2018.* Retrieved from: https://www.dmv.ca.gov/portal/wcm/connect/96c89ec9-aca6-4910-802b-c596f2625a7f/TeslaMotors.pdf?MOD=AJPERES&CVID=

Rogers, E. M. (2003). *Diffusion of innovations*. Free press. Retrieved from http://proxy.lib.chalmers.se/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=cat06296a&AN=clc.b1391659&site=eds-live&scope=site

Rysman, M. (2009). The economics of two-sided markets. Journal of economic perspectives, 23(3), 125-43.

Saplakoglu, Y. (2018, May 30). *Tesla on Autopilot Crashes into Parked Police Car.* Retrieved from: https://www.livescience.com/62692-tesla-sedan-crash-police-car.html

Saunders, M., Lewis, P. and Thornhill, A. (2016). *Research methods for business students*. Harlow: Pearson Education Limited.

Shepardson, D. (2018a, December 20). Uber resuming self-driving car testing in Pennsylvania. *Reuters.* Retrieved from https://www.reuters.com/article/us-uber-selfdriving/uber-resuming-self-driving-car-testing-in-pennsylvania-idUSKCN1OJ1OD

Sherman, E. (2018, November 15). *Ford Plans a Self-Driving Service – But Tech Problems Still Loom.* Retrieved from: http://fortune.com/2018/11/15/ford-self-driving-ride-share-service/

Somerville, H. (2018, August 21). Lyft surpasses 5,000 self-driving rides with Aptiv fleet. *Reuters.* Retrieved from: https://www.reuters.com/article/us-lyft-selfdriving/lyft-surpasses-5000-self-driving-rides-with-aptiv-fleet-idUSKCN1L61AX

Stangel, L. (2018, August 10). *Former Tesla exec Doug Field is returning to Apple to work on its self-driving car program.* Retrieved from: https://www.bizjournals.com/sanjose/news/2018/08/10/doug-field-apple-tesla.html

State of California Department of Motor Vehicles. (2019a). *Permit Holders (Testing with a Driver).* Retrieved from https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/permit

State of California Department of Motor Vehicles. (2019b). *Permit Holders (Driverless testing).* Retrieved from https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/driverlesstestingpermits

Statista. (2019). *Most valuable brands within the automotive sector worldwide as of 2018, by brand value (in billion U.S. dollars).* Retrieved from: https://www.statista.com/statistics/267830/brand-values-of-the-top-10-most-valuable-car-brands/

Talebpour, A., & Mahmassani, H. S. (2016). Influence of connected and autonomous vehicles on traffic flow stability and throughput. *Transportation Research Part C: Emerging Technologies, 71,* 143-163.

Taylor, E., & Oreskovic, A. (2015, February 14). Apple studies self-driving car, auto industry source says. *Reuters.* Retrieved from: https://www.reuters.com/article/us-apple-autos/apple-studies-self-driving-car-auto-industry-source-says-idUSKBN0LI0IJ20150214?feedType=RSS&feedName=technologyNews

Tesla. (2019a). *About Tesla.* Retrieved from: https://www.tesla.com/about

Tesla. (2019b). *Autopilot.* Retrieved from: https://www.tesla.com/autopilot

Train, K. E., & Winston, C. (2007). Vehicle choice behavior and the declining market share of US automakers. *International economic review, 48*(4), 1469-1496.

Uber. (2019a). *A guide for how to use Uber.* Retrieved from https://www.uber.com/us/en/ride/how-it-works/

Uber. (2019b). *Advanced Technologies Group.* Retrieved from https://www.uber.com/info/atg/

Uber. (2019c). *We believe in the power of technology.* Retrieved from: https://www.uber.com/info/atg/technology/

Uber ATG Safety Report 2018:01. *Uber Advanced Technologies Group: A Principled Approach.* Retrieved from https://uber.app.box.com/v/UberATGSafetyReport

Vaish, E. (2019, January 28). Volvo's self-driving car venture gets nod to test on Swedish roads. *Reuters.* Retrieved from https://www.reuters.com/article/us-volvo-autonomous/volvos-self-driving-car-venture-gets-nod-to-test-on-swedish-roads-idUSKCN1PM1J2

Von Corswant, F., & Fredriksson, P. (2002). Sourcing trends in the car industry: A survey of car manufacturers' and suppliers' strategies and relations. *International Journal of Operations & Production Management,* 22(7), 741-758.

Waldrop, M. M. (2015). Autonomous vehicles: No drivers required. *Nature News, 518*(7537), 20.

Waldrop, M. M. (2016). The chips are down for Moore's law. Nature News, 530(7589), 144.

Waymo. (2019a). *Our journey.* Retrieved from https://waymo.com/journey/

Waymo. (2019b). *What's next.* Retrieved from https://waymo.com/whats-next/

Waymo. (2019c). *Mission.* Retrieved from https://waymo.com/mission/

Waymo. (2019d). *Be an early rider.* Retrieved from https://waymo.com/apply/

Yakovlev, A., & Otto, P. (2018). The future of mobility: Shared mobility. *Ipsos.* Retrieved from: https://www.ipsos.com/sites/default/files/ct/publication/documents/2018-10/future-mobility-part-iii-shared-services.pdf

APPENDIX A: Description of interview sessions

__Questions regarding activities in the car__

Every interview session started with an introduction to the subject that was studied. The researchers explained what a fully autonomous car is and how it in the future can make the human driver redundant. The concept of autonomous cars was explained very briefly, just with a few sentences. The interviewee was informed that the aim with these interviews were to explore what people wanted to do in future fully autonomous cars, when they do not have to drive the car.

The first part of the interview was focused around the commuting habits of the interviewee. The following questions were asked:

- “Can you describe your commuting habits? Transportation mode/commuting time etc.”
- “Is there any different during the week and during the weekend?”
- “Do you use a car to commute? When? How many hours a week/per day?”
- “Do you have a driver’s license?”
- “Do you have a car?”

The second part of the interview was focusing on the interviewee’s everyday life, interests and routines.
The following questions were asked:

- “Can you explain a typical day? During the week and the weekend.“
- “Do you have any specific interests? What do you enjoy doing in your spare time?”

The next step of the interview was to start with the collage activity. The interviewee received the following instructions and was then given five blank paper with the category as a headline of each paper.

- “I will give you five sheets of paper and on every paper, you will find a category. For every category, your task is to express what activities you would like to be able to undertake in a future fully autonomous car, that you find related to that category. You can either write or draw. There are no right or wrong answers. Try to be honest and think in terms of your own life, your interests and your needs. For example for the category ”Relaxation”: think about what you like to do when you want to relax while riding in a fully autonomous car and express it in terms of a drawing or in words. Think about the fact that the activity should be possible to undertake in a vehicle, for example it might not be possible to lay on a beach in Hawaii.”

The interviewee was then asked to explain was he/she had written or drawn. The interviewer took notes and asked what the interviewee thought he/she needed in terms of software and hardware to be able to perform the activity.
The last step of this interview session treated the interviewee’s willingness to pay extra for an autonomous car. The following questions were asked:

- Would you be willing to pay extra for an autonomous car compared to a non-autonomous car?
- Why/why not?

- Would you be willing to pay extra for certain functions that makes the ride more convenient or facilitates you to perform certain activities?
- Why/why not?

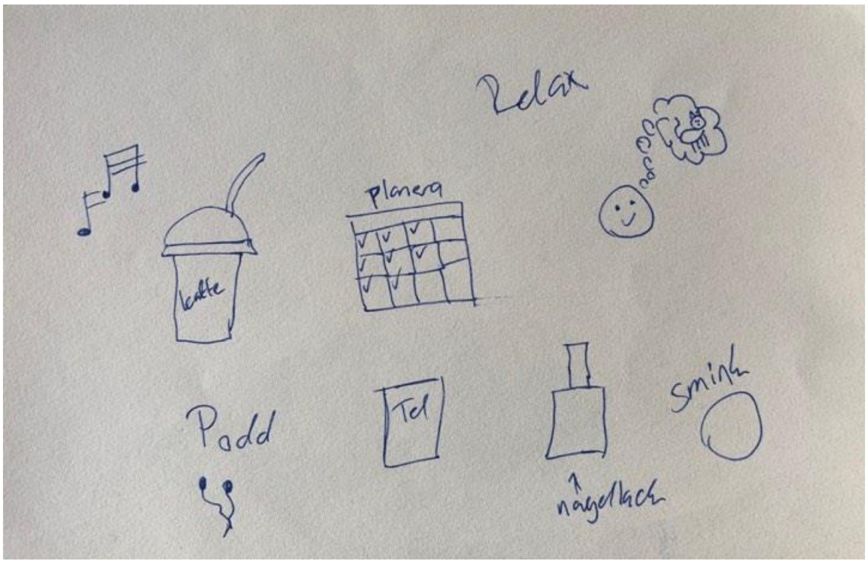
Questions regarding car sharing

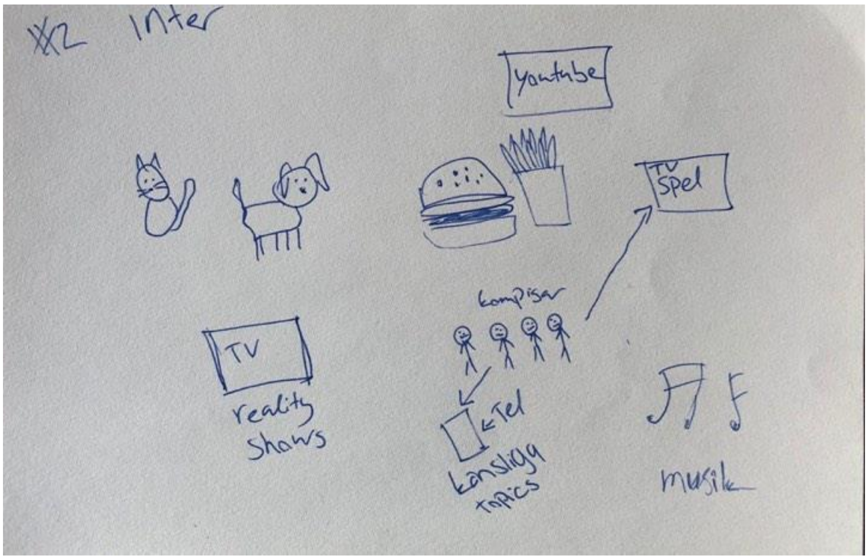
The second session of the interview was focused on the interviewee's car preferences and their view on car sharing.

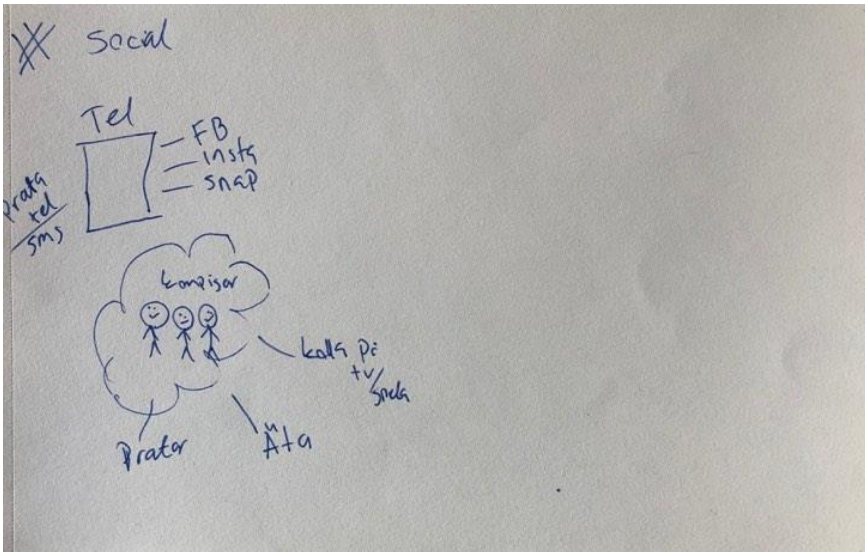
The following questions were asked:

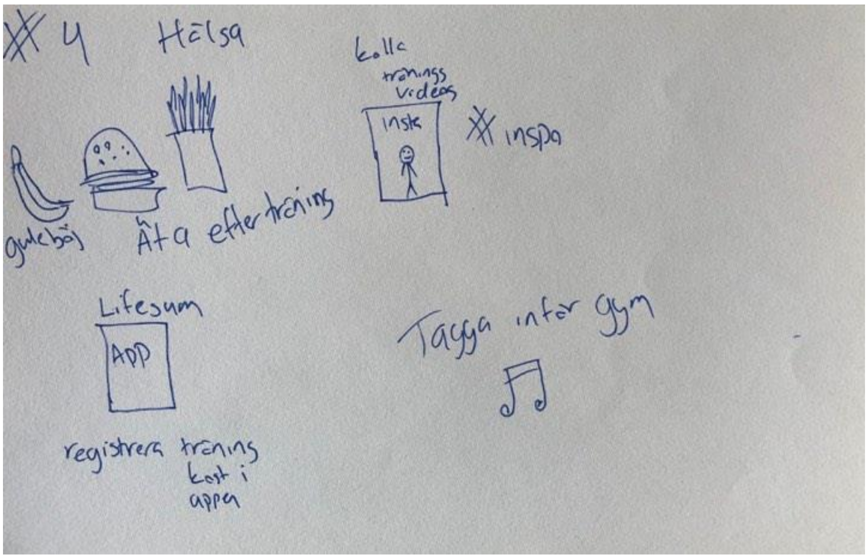
- What aspects did you value when you bought your car or if you would buy a car?
- Now imagine that you were going to sign up for a subscription of a car-sharing service. So, you would not own the car, and other people would use the same cars that you use, but not at the same time as you. In this situation, what aspects would you value?

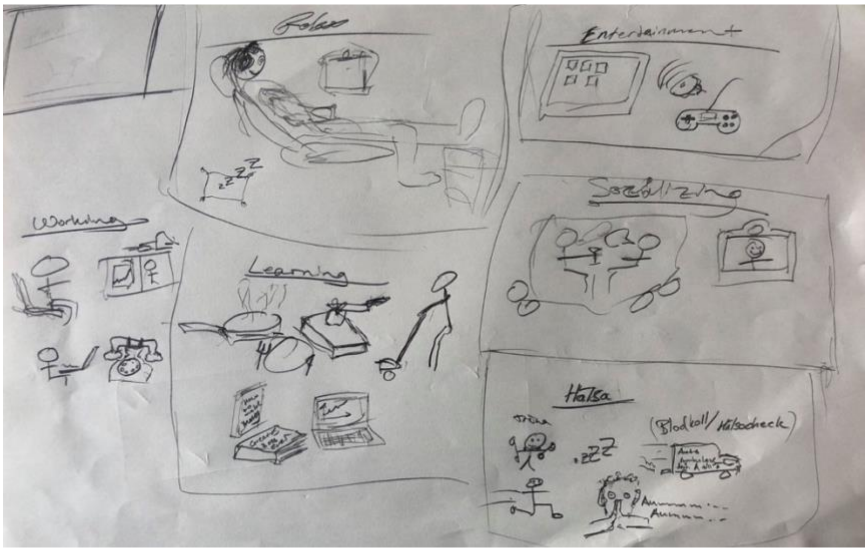
APPENDIX B: Examples of collages drawn by interviewees






Social
Tel
FB
insta
snap
prata tel
sms
kompisar
kolla på
tv/
spela
Prater
Äta


4 Hälsa
kolla
tränings
videos
insta
insp
Äta efter träning
Lifesum
APP
registrera träning
kost i
appen
Tagga inför gym


Relax
Entertainment
Socializing
Working
Learning
Hälsa
(Blodkoll/Hälsocheck)